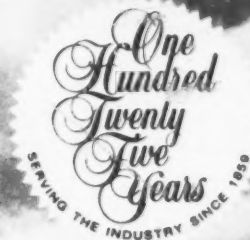


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**Peakshaving Forecast Report
Infrastructure Renewal
Construction Equipment Survey**

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Emphasis on renewal of the nation's infrastructure—water lines, sewer lines, highways, roads, bridges—will have major impact on gas utilities, whose mains and services will be disturbed, and the renewal programs will have great impact on gas distribution budgets, operations, construction and maintenance programs; a distinguished panel of 10 leading gas men discuss the problems and opportunities.

Record Peakshaving Capacity Ready For 1983-84 Winter Season 28

Distribution industry planning for cold winter, fine-tuning programs to provide for heavy demands; continuing decline in demand, suggestions of mild weather make planning a puzzle.

DistriGas: Success Story Of A Unique LNG Operation 40

The only successful LNG import operation in the U.S. is tailored toward supplying New England area gas utility company customers with either liquid—delivered by truck—or as a vaporized gas into the region's gas system.

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Equipment Needs, Uses Vary With Gas, Liquids Pipelines 44

Cross-country oil, gas, and products pipelines do relatively little of their mainline construction, about one-third of the gathering lines installed, and require specialized equipment for maintenance of pipelines and stations.

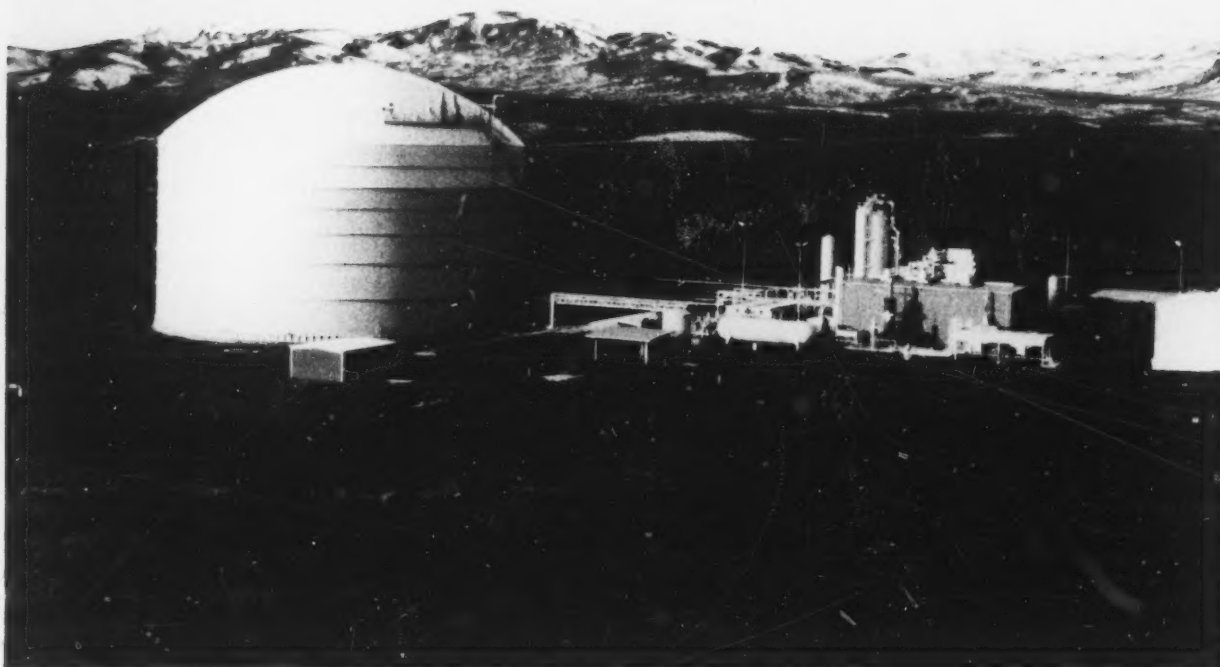


COVER

Propane-air plants supply only 7% of the peakshaving gas supplies but are very important because they generally serve towns and areas remote from other sources.

—photo courtesy Southern Union Gas Co.

Peakshaving Forecast and Report



Harold G. Laub LNG facility of Southwest Gas Corp. at Lovelock, Nev., was first LNG facility in U.S. completed under DOT 193 regulations; the 290,000 bbl storage tank is dominant feature of the plant that has liquefaction rate of 5 MMcf per day and vaporization rate of 105 MMcf per day, delivered at 900 psi and 60 F to the pipeline.

Capacity Increases Slightly, Industry Ready For Winter

by Dean Hale, Editor

Peak day demands on the nation's gas distribution system during the coldest day or days of the 1983-1984 winter will be anyone's guess, as the industry prepares for another unusual and frustrating time when overall customer gas usage is down and the variables of temperature and customer reaction are completely unpredictable.

The major problem, as pointed out to PIPELINE & GAS JOURNAL during its latest annual peakshaving survey, is that customers have been practicing conservation with determination—and that is reflected in overall lower gas sales for over a year now. But, when it really gets cold, conservation flies out the window and the demands on gas systems skyrocket. Blizzards, blue northerns, and extended cold spells can put great stress and strain on the best-made plans of gas men. Peakshaving supplies generally are more than am-

ple, but there may be instances where some classes of customers will have to be interrupted by some utilities—assuming that it does get that cold.

Meteorologists generally are forecasting a cold winter during the 1983-1984 season, but not one that is bitterly cold over an extended period. Regardless, with nearly 41 million gas customers heating their homes with natural gas, pipelines are expected to be operating at capacity and most of the nation's peakshaving facilities will be operating at some time, supplying supplemental gas to back up contract supply sources.

P&GJ's latest peakshaving survey indicates that a capacity of 75.13 billion cu ft maximum delivery for one 24-hr period, using gas from all available peakshaving gas sources, could be available if needed. To that could be added an estimated 67.6 Bcf of regularly scheduled

deliveries per day to produce a projected maximum delivery in one day that could reach 142.73 Bcf. Because the entire nation seldom experiences a major, nationwide cold spell simultaneously in all 48 contiguous states, it is doubtful that such a peak delivery could be attained.

A maximum total delivery of 76 to 86 Bcf in a single 24-hour period is projected for the 1983-1984 winter period for the gas industry. Supplemental gas supplies from LNG peakshaving plants, propane-air plants, and underground gas storage, as well as from other sources such as line pack, gas holders, SNG plants, etc., will provide a substantial portion of the gas demand at any specific time during the winter seasons in areas such as the northeastern and north central states, where extended periods of really cold weather have been known to prevail.

For the 1983-1984 winter season,

peakshaving supplies will include:

- 60.48 Bcf from underground gas storage
- 5.30 Bcf from propane-air plants
- 9.10 from LNG peakshaving and satellite plants
- 0.25 Bcf from other sources

The small increase in deliverability for the 1983-1984 marks the second year that the gas industry has reported only minimal gains in peakshaving capabilities after 14 straight years of substantial increases. Increases in underground gas storage capacities, resulting from new and expanded facilities, are offset by abandonment of older, less economical facilities. Only limited LNG peakshaving facilities increases are underway at this time, although interest in additional new facilities remains high. Additions to propane-air plants or new propane-air plant facilities were nominal during the year, mostly in improvements to existing plants and additional tank storage. "Other" sources that continue to be used include SNG plants (operated only if necessary because of the high cost of their feedstocks—naphtha, kerosene, other hydrocarbons), plus line pack, gas holders, some buried bottle-type storage, and enrichment of gas stream by direct injection of propane or ethane to boost the Btu content of the gas stream.

Underground Gas Storage

The search for new underground gas

storage containers—aquifers, salt domes, abandoned oil and gas fields, and tight caverns—is being continued by gas pipelines and gas distribution companies. The need for such storage is obvious—for every two Mcf of new daily demand that is sold or created, another Mcf of peakshaving capacity must be provided. The actual range is from 0.2 to 0.8 Mcf for each Mcf unit of demand, because every company is different, with the average at 0.5 Mcf.

During 1983, the gas industry spent \$198 million for storage facilities—drilling and completing injection and withdrawal wells, observation wells, installation of new field lines, installation of new compressor horsepower, and installation of related measurement, dehydrating, filtering, and odorization equipment and control systems and communications systems.

As of November 1, 1983, there were 409 underground gas storage fields being operated or developed by 104 companies, including 398 fields considered active, another 11 under development. Maximum deliverability of the 398 fields is estimated at 60.48 Bcf per day in a 24-hr period.

At the 409 operating and under-development gas storage fields, there are 18,536 wells (a net increase of 222 over 1982), 7162 miles of field lines (up 152 miles), and a net gain of 13 compressor stations (net total of 298) with a net in-

crease of 30,430 hp for the year; net total of 1,720,554 hp.

Preliminary data for 1984 indicates that 135 new wells will be drilled, over 330 will be worked over, 96 miles of new field lines are planned, and over 15,000 hp will be added. Projections do not include requirements of projects not yet publicly announced.

Current gas storage developments include:

Battle Creek Gas Co. is developing the Lee 2 field in Calhoun County, Mich., which is expected to have an estimated working capacity of 750 MMcf.

Michigan Gas Utilities Co. is planning to develop the Campbell Field, in Calhoun County, Mich., for storage service. It will have an estimated capacity of 300 MMcf.

Consolidated Gas Supply Corp. is continuing reconditioning work (cost: \$1 million) in 1984 on its Lost Creek Storage Field in Lewis and Harrison Counties, West Va.

B.C. Hydro and Power, Vancouver, British Columbia, has signed agreement with **Washington Water Power Co.** of Spokane to use part of the latter's share of the Jackson Prairie storage facility near Chehalis, Wash. B.C. Hydro will store up to 2.824 billion cu ft in the summer and, by exchange, receive the gas back in the winter. Agreement is for five years—through April 30, 1988.

(Continued)

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Propane-Air Plants

Propane-air plant changes were insignificant during 1983. One new plant was installed, bringing the total to 505 propane-air plants now operated by 242 gas utilities in 41 states. Several plant revisions were reported, and total deliverability increased slightly to 5.3 billion cu ft per day total. An estimated 4 million gal. of additional propane storage was added at both new and existing propane-air plants during 1983.

LNG Peakshaving Developments

New Jersey Natural Gas Co. has received necessary state and local approvals to expand its satellite facility in Howell Township. Construction of the 117,000-bbl capacity storage tank and addition of the 60 MMcf per day submerged combustion vaporizer is ongoing. Excavation for the tank foundation began in August. The added capacity should be onstream by late 1984. The New Jersey Board of Public Utilities required that the addition comply with the Department of Transportation's Material Transportation Bureau (MTB) Safety Standards contained in the Code of Federal Regulations Title 49, Part 193. PDM is the prime contractor for both the systems and the suspended deck storage tank.

North Carolina Natural Gas Corp. has temporarily postponed its plans to construct an LNG peakshaving plant. Conservation and loss of industrial gas loads were cited as reasons behind the decision.

Energy Terminal Services (ETS) continues to process its application to convert its Staten Island Terminal site into a peakshaving facility. The present holdup in the approval process is related to compliance with MTB's safety standards involving the adequacy of flammable vapor-gas dispersion exclusion zone. FERC has required compliance with MTB's safety standards as part of its Section 7 approvals under the Natural Gas Act.

In Europe, activities remain slow in the area of LNG peakshaving. Peakshaving requirements, however, are expected to increase substantially. In terms of cost, Nederlandse Gasunie forecasts that peakshaving will increase from its present 4% of the consumer price to 11% in the 1990's. The same report spoke of a doubling of underground storage requirements. The increased need for peakshaving capacity is attributed to a steady shift towards residential/commercial sales and away from industrial. The decline in industrial sales was reflected in Ruhrgas' 1982 annual report.

Base-Load LNG Developments

In the past year, two new LNG projects have been implemented: Malaysia-Japan and Indonesia-Japan (expansion). In addition, Indonesia and Korea have agreed to implement a project beginning in 1986-1987.

The initial cargo of LNG in the Malaysia-Japan project was loaded at the Bintulu, Sarawak LNG Plant on January 29 aboard the *Tenaga Satu*. She sailed on January 30. The cargo was delivered to the Sodegaura terminal in Japan on February 7.

Final negotiations involving pricing for the LNG were reportedly concluded between exporter and importers earlier in January. Terms have not been disclosed but are believed to call for c.i.f. price that is close to but slightly above those currently in effect for Indonesia, Brunei, and Alaska, which now average approximately \$4.90/MM Btu c.i.f.

The LNG exporter is Malaysian LNG

Sdn Bhd, owned 6.5% by Petronas—the Malaysian state petroleum company, and 17.5% each by Shell Gas B.V. and Mitsubishi Corp. The LNG buyers are Tokyo Electric Power Co. Inc. (TEPCO) and Tokyo Gas Co., Ltd. TEPCO will take approximately 4 million tons per year (580 MM CF/d) and Tokyo Gas approximately 2 million tons per year (290 MM CF/d) at plateau volumes over the 20 year contract. Deliveries in 1983 are scheduled to be approximately 1.7 million tons (246.5 MM CF/d). That will increase to 3 million tons (435 MM CF/d) in 1984 and 4.5 million tons (652.5 MM CF/d) in 1985. Tokyo Gas and TEPCO are also constructing a new terminal at Higashi-



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Ogishima, Kawasaki to receive Malaysian LNG.

The other four Malaysian LNG tankers that will service the trade are still reportedly in layup in Norway awaiting their scheduled entry into the trade. The first train of the three-train plant has reportedly had no significant problems coming on stream. It is understood that the other two trains are nearly mechanically complete. It is reasonable to expect that the second train would be brought on stream around mid-year and the third about year's end.

The first lifting from the P.T. Badak plant under the expansion contract was made on August 25. The lifting made by

the *Bishu Maru*, which underwent its gas trials in Japan prior to sailing for Bon-tang Bay. The event marked the first lifting of an LNG cargo by a Japanese flag vessel. An as yet unspecified number of cargoes are to be lifted this year under the 1981 contract from Trains C and D at the Badak plant.

The start-up and first month's operation of Train C is understood to have been remarkably smooth. By early August, production capacity had reportedly reached 135% of design. In September, Train D started producing LNG into storage and was expected to be at full capacity in October. The amount of LNG produced from Trains C and D over and

above contract commitments is expected to be used to replace lost production from Train B. Train B at the P.T. Badak plant was severely damaged in an accident on April 14.

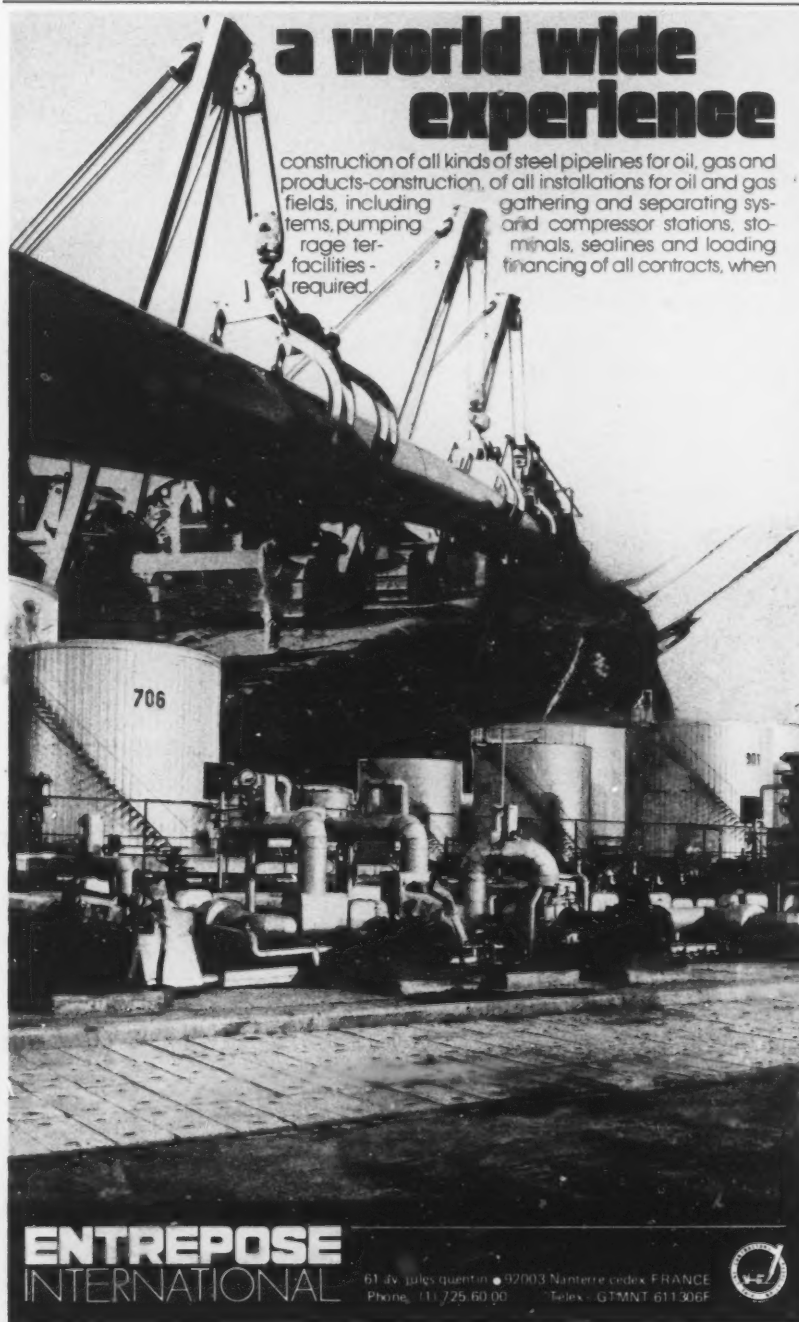
On August 12, General Joedo Sum-bono, President-Director of Pertamina, and Park Jung-Ki, President of Korea Electric Power Corp. (Kepco), signed the long awaited gas supply contract. Under the contract, Pertamina will sell Kepco approximately 2 million tons of LNG annually (290 MM CF/d) for a period of 20 years beginning in late 1986 or early 1987. The LNG will come from a sixth train to be constructed at the P.T. Arun LNG plant at Blang Lancang, North Sumatra. It will be delivered to a terminal to be constructed by Kepco near Pyontack on Asan Man Bay. Shipping arrangements for the gas, which is to be sold on a c.i.f. basis, will be by chartering of existing hulls. Regarding pricing provisions, as with other Indonesian contracts, the base price will be linked to the average export price of Indonesian crude oils. Based upon the quantity of LNG and the value of the contract as stated at the signing ceremonies, the current c.i.f. price Korea should be approximately \$5.12/million Btu.

The plant expansion involving the construction of the sixth train is expected to cost \$400 million according the press reports. The main cryogenic exchanger for the train was moved to the P.T. Badak plant where it was being installed in place of the exchanger destroyed in the April 14 accident. When the replacement exchanger for P.T. Badak's Train B is received in mid-1984 from Air Products and Chemicals, Inc., the Arun exchanger will be removed and returned for installation in Train 6. Contracts for this phase of the P.T. Arun expansion have not been awarded. It would appear reasonable to expect that Chyoda Chemical Engineering and Construction Company, Ltd., would receive the contract. It is the general contractor for the current plant expansion involving Trains 4 and 5.

The LNG carriers chartered for the project are Gotaas Larsen's *Golar Spirit* and Lief Hoegh's *Hoegh Gandria*.

Worldwide LNG Developments

The base-load LNG industry's prospects were deliberated at the opening session of the Seventh International Conference on Liquefied Natural Gas held in Jakarta, Indonesia in May. The 1800 delegates heard industry prospects delivered in the opening session, "LNG and World Wide Energy Supplies" at the first workshop session, "Prospects for Expanded LNG Trade" and by some of the keynote speakers. Malcom Peebles succinctly summarized the growth prospects for world LNG trade in his opening session paper when he revealed that his current "high" estimate for trade growth equals his "low" estimate of just



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3 years ago. The question was properly raised as to whether this is a reflection of the world's current economic malaise or perhaps more fundamental changes in gas markets.

For Europe, a modest increase in demand for natural gas can be seen if the price of imported gas supplies maintains a competitive position. An increase in demand coupled with potential shortages in supply in the 1990's could lead to opportunities for both pipeline and LNG projects. Whether LNG projects can fulfill the gap will depend on the trading terms reached between exporter and importer. The long-held opposing views between exporter and importer as to how gas pricing mechanisms should be structured, unfortunately, remain and were again voiced at the conference.

It was most interesting to hear Japanese buyers, for the first time, state that their market, by far the largest of the three, has undergone fundamental changes. Peebles also identified this change. The Japanese LNG market is dominated by its use in electric power generation and the change is being felt there. Although it might appear to have been more appropriate to have this subject addressed by speakers from the Japanese electric power industry, it was given a most capable treatment by speakers from Japan's gas utility industry. The decline in industrial power demand due in part to collapse of materials industries, which are large consumers, has led to a situation in which a surplus generating capacity is forecast to exist. This condition, which had not existed previously, will result in increased competition among fuels used in power generation. For a number of reasons, LNG ranks below nuclear and coal competitiveness and is only marginally superior to oil. According to the Japanese speakers, for LNG to regain a competitive position, its price must be reduced and its flexibility in terms of take-or-pay quantities — especially in the buildup period — must be enhanced. To do so will require changes in traditional trading terms. If not realized, development of new projects will be confined to those that replace the ones whose term and available gas reserves have been exhausted or to incremental additions for existing projects, which reflects the minimal growth in Japanese demand and new markets in Asia.

The United States does not appear ready to support any new LNG project development until such time as long-term supply contracts again become attractive on the political and regulatory scene.

As a consequence, it appears that growth in world LNG trade beyond those projects that are more or less rigidly defined and accepted as ultimately being realizable, such as Australia and Dome's Western LNG, is likely to be characterized by small-sized projects with phased

development. This may be coupled with a trend toward lowest possible capital costs rather than energy efficiency.

To implement these prospective projects will require that certain actions be taken in the near term even though near-term prospects are bleak. Postponement to the time when a more favorable world economic climate may exist could incur risks of losing a viable business opportunity as suppliers of competitive fuels are unlikely to defer until partners in an LNG project reach agreement on a project structure. Such agreement is critical to the financial community that is perceived as becoming more conservative in its view of LNG projects and to govern-

mental officials with commercial, policy, and regulatory responsibilities.

The positive notes are that 1) when taken on balance, the longer-term view of world trade shows the positive factors outweigh the negative, 2) LNG can be delivered at costs which are competitive with other fuels and at prices even below those for high cost gas supplies, 3) there does appear to be a tacit understanding developing between some sellers and buyers that accommodations will need to be reached so that development of new projects may occur in this century, and 4) other means for moving gas in international trade, such as methanol, have not gained a competitive edge. **P&GJ**

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COVER

A little snow won't stop this crew from Wisconsin Gas Company from doing their bit in the expansion of the U.S. gas utility piping system.

—photo courtesy Wisconsin Gas Co.

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Increased Emphasis On Maintenance Hikes 1984 Outlay To \$3.76 Billion 18
U.S. gas utilities will spend almost \$4 billion on expanding, upgrading, maintaining, and repairing the nation's gas distribution network.

Plastic Pipe Makes Big Move In 1983 20
Plastic pipe accounted for 88.6% of all piping installed by gas utilities in 1983, a total of 19,920 miles of plastic pipe.

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A. Plenty! 22
Some of the most common problems facing gas utilities are discussed, along with suggested remedies.

Large Diameter Insert Renewal Made On Medium Pressure Main 32
National Fuel Gas has completed a gas main insertion project in Buffalo, N.Y., involving the insertion of 10-in. PE pipe into an existing steel system.

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Distribution Piping Forecast

Maintenance Hikes 1984 Outlay To \$3.76 Billion

by Jim Watts, Assistant Editor

The U.S. gas distribution network is benefitting from an increased emphasis by utilities on maintenance and repair of their existing system. Results of the 18th annual PIPELINE & GAS JOURNAL distribution piping survey show expenditures for new and replacement mains and services only slightly ahead of expenditures for system maintenance and repair.

An estimated \$3,764,883,700 will be spent on system maintenance, repair, replacement, and extension in 1984, up from the estimated \$3,689,030,500 spent in 1983.

Figures show that the estimate in the 1982 survey on 1983 expenditures for new and replacement mains and services, \$1,735,884,100, was very close to the final figure for 1983 in the new survey, \$1,757,231,200.

However, the earlier estimate of \$925,970,400 for maintenance and repair in 1983 was far too low. The actual figure was \$1,631,799,300, up 76% from the 1983 estimate and more than 92% above the \$848,819,350 spent on system maintenance and repair in 1982.

Utilities say they expect to spend \$1,973,958,700 for new and replacement mains and services and \$1,790,925,000 for system maintenance and repairs in 1984.

If all the money expected to be appropriated for work in 1984 is indeed spent, the figure will be the largest to date in U.S. history.

Another 22,470 miles were added to the nation's gas distribution network in 1983—10,950 miles of mains and 11,520 miles of services. With the latest additions, the U.S. distribution network totals 1,403,403 miles as of Dec. 31, 1983, including 853,941 miles of mains and 549,462 miles of services.

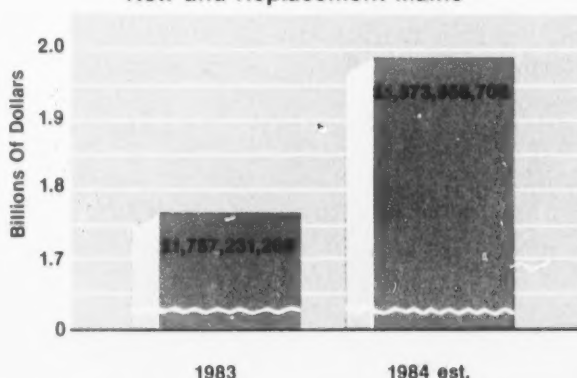
The growth will continue in 1984, with an estimated 12,229 miles of mains and 12,593 miles of services expected to be added.

The increasing importance of maintenance and repairs as a function of gas utilities can be noticed in maintenance's increasing share of the budget. Maintenance and repairs accounted for 36.6% of the total construction budget in 1981 and 36.1% in 1982—rising to 44.2% in 1983 and an estimated 47.5% in 1984.

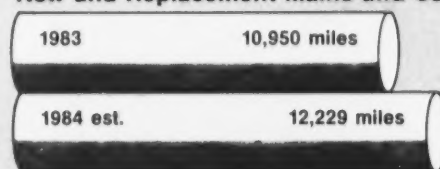
An estimated 574,000 new gas customers were added by utilities in 1983, compared to 427,000 new customers in 1982. Utilities say the total includes 478,000 new residential customers attributed to new construction, 82,000 customers switching to gas heating from other fuels, and 14,000 new industrial and commercial customers.

The survey polled more than 350 gas utilities, including the 300 largest as reported in the August 1983 PIPELINE & GAS JOURNAL, serving more than 97% of U.S. gas customers.

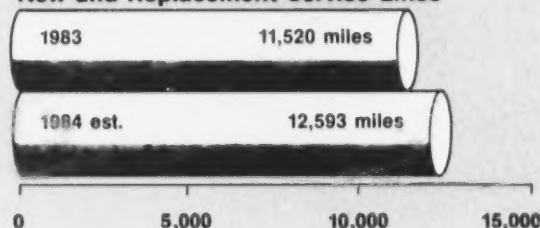
New and Replacement Mains



New and Replacement Mains and Services



New and Replacement Service Lines



Contractor Usage Varies

Asked if they were relying upon outside contractors more in 1983 than in the past, most respondents said they were being forced to cut back on outside help due to a tightening of budgets and a slowdown in work. Generally, gas company executives said they relied on company crews to maintain a certain level of construction, going to distribution contractors only when the work

grew too heavy for company personnel.

However, many of the larger utilities say they increased the percentage of work going to contractors due to large renewal and replacement programs. Utilities that have an extensive program of replacing their cast iron or bare steel systems with coated steel or plastic pipe say they used outside contractors for much of the work. That practice left company crews available for leak repairs and isolated maintenance duties.

There are definitely two schools of thought in the use of outside contractors. Many utilities say they used company crews to do construction work because it is cheaper; others tell PIPELINE & GAS JOURNAL that they found it cheaper to cut back on the company work force due to the seasonal aspect of the work in much of the country. The flexibility of hiring a contractor when work must be performed and not having to maintain a large company payroll is attractive to these companies.

Some say they feel they have better control over the quality of the work done by company crews than by an independent

contractor. Others report that they have used outside contractors for more than 90% of their work for years and are completely satisfied with what they are getting.

Below is a sample of the comments on the question, "Have you increased or decreased the percentage of work awarded to contractors? Why?"

"Decreased, because with the slowdown in construction we have the time and manpower to do our own."

"The percentage of work going to contractors has been down. We use our own crews for routine construction and use contractors to help us out when things get busy. Since we haven't been that busy, we haven't had as many occasions to go outside."

"Decreased because of more construction done by company employees."

"Due to mild winter, the percentage of contractors' work has decreased, although now it is starting to pick up again."

"We are doing as much as possible with our own personnel to cut total expenditures."

"Decreased, contractors cost too much."

"Decreased, company personnel are capable of most construction."

"We are utilizing our own personnel to a greater extent."

"Increased. Due to some manpower cutbacks and normal attrition our construction work force has been cut by 50%. Our employees are mainly concentrating on gas systems repairs rather than new construction."

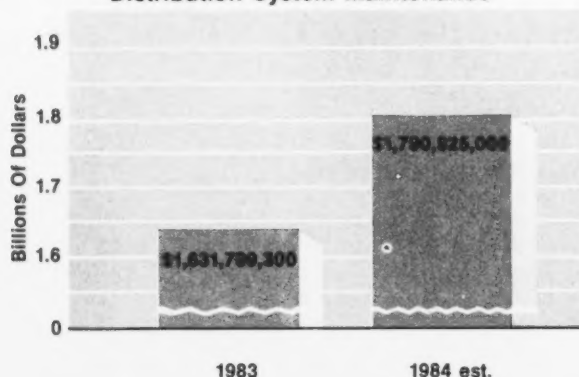
"Increased. More flexibility with labor requirements result in overall savings."

"Increased due to increased replacement program. Frees our personnel for isolated leak repair and required monitoring."

"Due to the size of our replacement program we decided to contract most of the work."

"We have increased the amount of construction of mains and services being done by contractors due to seasonal nature of this type of work."

Distribution System Maintenance



One-Call Systems: Useful If Used

One-call systems, designed to warn third-party excavators of the presence of gas lines near a job site, are becoming increasingly popular. Damage by a third party cannot only be expensive, it can be very dangerous. Recognizing this, utilities are organizing and participating in one-call systems. In some cases, formation of warning networks is mandated by state or local authorities. Most members say such systems are very helpful; some say the expense has outweighed the benefits.

The problems involved in a one-call, or call-before-you-dig, program are many. Some utilities have only a vague idea where some of their lines are, and remapping is very expensive. Coordinating all the utilities that have underground lines—gas, electric, water, sewer, and cable TV—can be complicated. The biggest problem of all is getting excavators to participate.

In areas where one-call systems exist, gas utilities sometimes have a hard time getting excavators to tell them where they are going to dig. The best compliance is where a state or local law requires a permit before excavation can be performed.

Where a one-call system is in place and outside contractors are required to cooperate, safety records are very high. Otherwise, compliance rests upon responsible contractors who recognize the dangers involved before digging without knowing—or caring—what lies below the surface.

P&GJ asked utilities: "Do you have a one-call system designed to prevent accidental dig-ins? If so, has it proved beneficial?" Replies included:

"Yes, it is a good thing."

"We are in a one-call system but have had some problems with compliance."

"No, but I wish we did."

"How beneficial seems to depend upon individuals doing the locating. Experience is a big factor."

"Anyone who digs in our area needs a digging permit."

"We belong to six such systems and are currently joining another. We consider them beneficial, but it's difficult to quantify benefits."

"State penalizes contractors who don't give proper notification."

"It's beneficial if people use it."

"The system has been in use for many years and is well organized. During 1982, of 198 accidental dig-ins (89 services, 13 mains), majority were by all contractors or home owners. The other 30% were by failure to hand dig."

"We operate an one-call system, and it has proved very beneficial."

P&GJ

P&GJ Plastic Pipe Survey

Plastic Pipe Makes Big Move In 1983

P&GJ Staff Report

Plastic pipe made a big move in the gas distribution market in 1983, accounting for an estimated 88.6% of all piping installed in the year. Preliminary estimates for 1984 indicate plastics percentage will drop in the next 12 months, to 78.5% of the total installed.

Based on the current piping survey as well as earlier reports, plastic pipe appears to have reached a plateau in the U.S. It is unlikely that the percentage of plastic pipe will dip below 70%, but it is also unlikely that it will go above 90% in the foreseeable future.

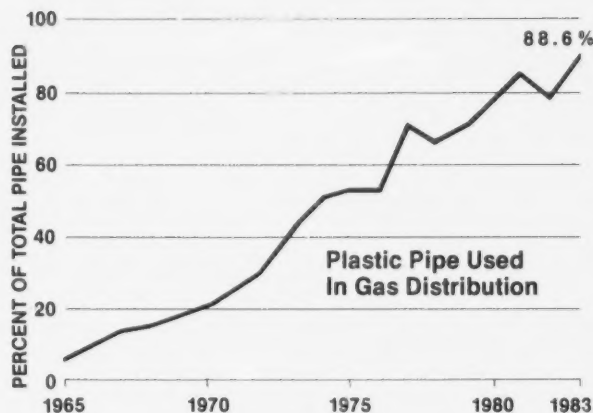
In general, plastic pipe has made its biggest inroads on steel in the larger markets. Plastic pipe is winning more and more converts for a variety of reasons. It is easier to transport and install than steel pipe, it requires no cathodic protection, and it can be installed without the need for welders and other highly trained personnel. Those reasons and more are very attractive to large as well as small gas utilities.

However, many small utilities are resisting the trend towards plastic pipe. The advantages outlined above are not so important to them, and they feel comfortable with steel pipe, which has proved its value and utility over many years.

Utilities installed a total of 22,470 miles of piping during the year. Of the total, 19,920 miles were plastic. Of the 24,822 miles expected to be installed in 1984, an estimated 19,494 miles will be plastic.

Executives at 350 gas distribution utilities across the U.S. were asked, "Are you using more plastic pipe now? Why? If so, how has it changed your procedures and equipment inventory?" The answers include:

"Conversion of equipment has been a major expense, and we



have had major changes in employee training, with retraining on an annual basis. We are using plastic anywhere that conditions permit."

"Management is committed to total plastic distribution system. We have gone almost totally to mechanical fittings."

"We are using 98% plastic pipe now for economic reasons and in an effort to reduce cathodic demands."

"We had to tool up for plastic pipe installation and learn new procedures."

"Steel pipe is now ordered only for specific jobs. Inventories are kept to a minimum."

"Each year we tend to use more plastic pipe than in years past."

"We use plastic pipe for cast iron inserts only."

"Plastic pipe is easier to install and maintain."

Another advantage plastic pipe has over cast iron or steel is the lack of a need for a replacement program. There may be a change in that as the plastic approaches the age of some of the cast iron or steel systems in the U.S., but so far there appears to be no need for a replacement program, according to answers to the question, "Do you have a replacement program for plastic pipe?"

"We have used plastic pipe for 14 years and it is performing satisfactory. We have no evidence to indicate that replacement should be considered."

"No, and I hope we never need one."

"The only plastic replacement taking place at this time is that of replacing earlier inferior types of plastic pipe."

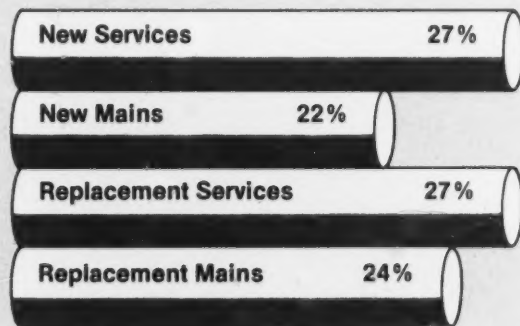
"Yes, replacement of all PE 3306 services on a three-year program."

"We do have a monitoring system. The life of plastic pipe in service still must be determined."

"The older type plastic mains and services are occasionally replaced, but there is no schedule."

P&GJ

Where Gas Utilities Use Plastic Pipe



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COVER

The ubiquitous welder typifies the pipeline construction scene — one that, in 1984, will be seen on many smaller but more numerous projects.

—photo courtesy
Wisconsin Gas Co.

JANUARY 1984 • VOLUME 211 • NUMBER 1

Adaptable Contractors Will Thrive In Changing Domestic Market 18

Projects will be smaller, but there will be more of them, requiring more but smaller contractor operations during 1984, say participants in P&GJ's 14th annual Contractors Roundtable; both equipment and contractors will have to be able to do more than one job.

Pipelines' Economic Advantages Will Aid Industry, Contractors Say 24

Pipelining will be active in widely scattered areas of the world as demand for energy keeps pace with increased level of economic activity projects that make economic sense come to fruition, say participants in P&GJ's International Pipeline Contractor Roundtable.

Modest Construction Year Seen In 1984 For U.S., Canada Pipelines 28

Pipeline construction activity in 1984 in U.S. will focus on shorter main lines, loop lines, laterals, and continuing expansion of oil and gas gathering systems.

What's New in Construction Equipment 36

Gas Utility Equipment Ownership, Utilization Changes Notable 40

Gas distribution utilities are using bigger, more productive equipment and more efficient construction operations to accomplish needed replacement, maintenance, and repair work; utilities own over 202,750 units of construction equipment, major tool items, and units of transportation equipment, according to P&GJ Construction Equipment Census.

Helicopter Pipelift Gets Beluga-Anchorage Line Underway 44

First step towards construction of new 100-mile 20-in. gas pipeline in Alaska required offloading pipe from barges by helicopter.

Modest Construction Year Seen For U.S., Canada Pipelines

by Dean Hale, Editor, and Jim Watts, Assistant Editor

Pipeline construction activity in 1984 in the U.S. will focus on shorter main lines, loop lines, and laterals, along with continuing expansion of oil and gas gathering systems.

As of Jan. 1, 1984, planned and proposed pipeline projects in the U.S. totalled 30,072 miles. For 1984, an anticipated 8385 miles of new trunk pipelines and gathering lines will be constructed, including 4280 miles of oil and gas gathering lines and 4105 miles of gas transmission, crude oil, products, and CO₂ pipelines, according to PIPELINE & GAS JOURNAL's annual survey of U.S. pipeline construction.

Pipeline company executives and planners attribute the lessened activity to a continuing lower demand for hydrocarbon energy and reduced exploration and developmental activity in 1984 and a likelihood of increased energy demand, a need for more pipeline transportation could boost pipeline construction plans beyond current expectations.

Total of all planned and proposed projects in the U.S. and Canada is 41,055 miles. Canadian pipeline construction activity tumbled to slightly less than 1600 miles during 1983 (after a record year in 1982) and the outlook for 1984 is for a total of 1550 miles of all types of pipelines. Most of that work will be relatively short trunk lines, laterals, and oil and gas gathering systems.

The 1984 forecast of 9925 miles of new pipelines to be constructed is predicted on 1983 year-end economic predictions and, with an upsurge in the economy, could improve markedly. Industry executives and analysts note that there is pent-up demand for pipeline transportation facilities. Getting several major projects underway that are now on "hold" would provide a welcome stimulus in the pipeline field.

Gas Pipelines

Lots of gas pipeline work has been planned for the northeastern U.S., but only one of the three proposals to import additional large volumes of Canadian gas is going to get approval

of the Federal Energy Regulatory Commission. The FERC has consolidated hearings on the three-Trans-Niagara, Boundary, and Niagara Interstate Pipeline System—to determine if they are competitive and see if any are ready for hearings. NIPS is expected to have the best chance.

The Niagara Interstate Pipeline System, originating near Buffalo, N.Y. where 0.2 miles of 36-in. dual pipeline would carry gas across the Niagara River, would involve 48.6 miles of 48-in., and 112.7 miles of 42-in. enroute to Transco's Leidy storage field in northwest Pennsylvania. Capacity would be 2.52 Bcf per day; cost would be \$417.6 million. Boundary Gas (Tennessee Gas Pipeline) now plans only 104.5 miles of 10 to 30-in. instead of 257 miles of 10 through 42-in.

Texas Eastern plans expansion to accommodate additional imports with three loops on its system in Pennsylvania.

Arkla Gas is planning a 120-mile, 30-in. line from Gurdon, Ark. to Monroe, La. so it can sell additional gas to Southern Natural. Transcontinental Gas Pipe Line Corp. plans to expand its southwestern Louisiana gathering system with 50.6 miles of 42-in.

Mantaray Pipeline Co. (Panhandle Eastern Corp.) has announced plans to build 105 miles of 24 and 36-in. of the south Texas coast, connecting reserves off Matagorda Island to Trunkline Gas in Victoria County.

Natural Gas Pipeline Co. of America plans to replace all of its No. 1 Amarillo line and its existing compression with loops and modern compression. Eventually, 301 miles of new large diameter loop will replace 475 miles of older, smaller line.

Decline of gas transmission lines' activity can be seen in FERC data relating to filings for construction: in first 11 months of 1983, 156 filings for 2252 miles, 162,060-hp, all costing \$1.311 billion; in first 11 months of 1982, there were 243 filings for 2135 miles, 241,926-hp, at cost of \$2.772 billion; in first 11 months of 1981, there were 263 filings for 3907 miles, 383,905-hp, costing \$3.077 billion.

Crude Oil Pipelines

All-American Pipeline Co., now a unit of Celeron Corp., a subsidiary of Goodyear Tire & Rubber Co., is aggressively pushing its 1200-mile, 30-in. project from Santa Barbara County, California, to near Midland, Texas. Federal and California state officials have "deemed complete" the line's applications for permission to cross federal and state lands. Route of most of the line will follow existing pipeline corridors, making required environmental impact studies easier to prepare.

Status of the Pacific Texas Pipeline Co., a 1026 mile, 42-in. line proposed from Long Beach to Midland, remains unknown. Pacific Texas sponsors have not commented on their project for nearly a year.

Most intense crude oil pipeline activity seems to be occurring at a very unlikely spot—the North Slope of Alaska—where more than 100 miles of crude lines and related flow lines for production and waterflood are being installed. Work at Prudhoe Bay and nearby Kuparuk Field will continue at a high level in 1984.

Big news of 1983 in crude oil lines included completion of the 288-mile, 20-in. Frontier Pipeline in Wyoming and cancella-

1984 PIPELINE OUTLOOK

Miles Planned or Proposed

Type of Line	U.S.	Canada
Natural Gas	9,968	8,412
Crude Oil	3,383	908
Products	3,231	813
Slurry	10,168	500
CO ₂ (Carbon Dioxide)	3,322	350
	30,072	10,983

Projected Completion, Miles

Type of Line	U.S.	Canada
Natural Gas	2,870	
Crude Oil	630	1,550
Products	405	
Slurry	—	
CO ₂	200	
Oil/Gas Gathering	4,280	
	8,385	1,550

tion of the 1491-mile, 40 and 42-in. Northern Tier Pipeline from the Seattle area to Clearbrook, Minn.

Oil from the offshore Santa Barbara fields will likely be transported to Los Angeles area refineries through one of several pipelines now being studied by Standard Oil of California and ARCO; route would range from 135 to 250 miles and pipe diameter will probably be 24-in.

Products Pipelines

A relative limited amount of products pipeline construction is expected in 1984 as refiners, pipeliners, and marketers continue study and match demand and supply.

Major projects being planned include 130 miles in Texas by Texas Eastman; the Phillips/HTI/Mapco 820 miles of 10-in. from Williston, N.D. to Conway, Kan.; and Transgulf Pipeline's conversion of the 890 miles of 24-in. gas pipeline to products service plus numerous laterals.

Slurry Pipelines

Rejection of the *eminent domain* bill for coal slurry pipelines in the U.S. House of Representatives hit hard at the U.S. coal slurry pipeline business. The vote against the bill crunched more than eight years of hard work by slurry pipeline planners and their lobbyists in Washington, especially after early readings of congressional opinion indicated a favorable vote was probable. The turnaround came after a strong and determined effort by

the railroad lobby, which also appealed strongly to Midwestern and Western congressmen concerned about "water rights."

Energy Transportation System Inc.'s 1400-plus mile planned line from Wyoming to Arkansas is being restructured after Arkansas Power & Light Co. elected to utilize unit coal trains on the Burlington Northern and Missouri Pacific railroads instead of the coal slurry pipeline. ETSI is now looking at potential power plant users in Oklahoma and Texas.

Sponsors of the Powder River Pipeline slurry project cancelled their plans, and most of the other major projects are on "hold" until further action can be taken on the *eminent domain* question.

Most viable slurry projects currently are two lines that will carry phosphate ores from mine areas to fertilizer plants.

Carbon Dioxide Pipelines

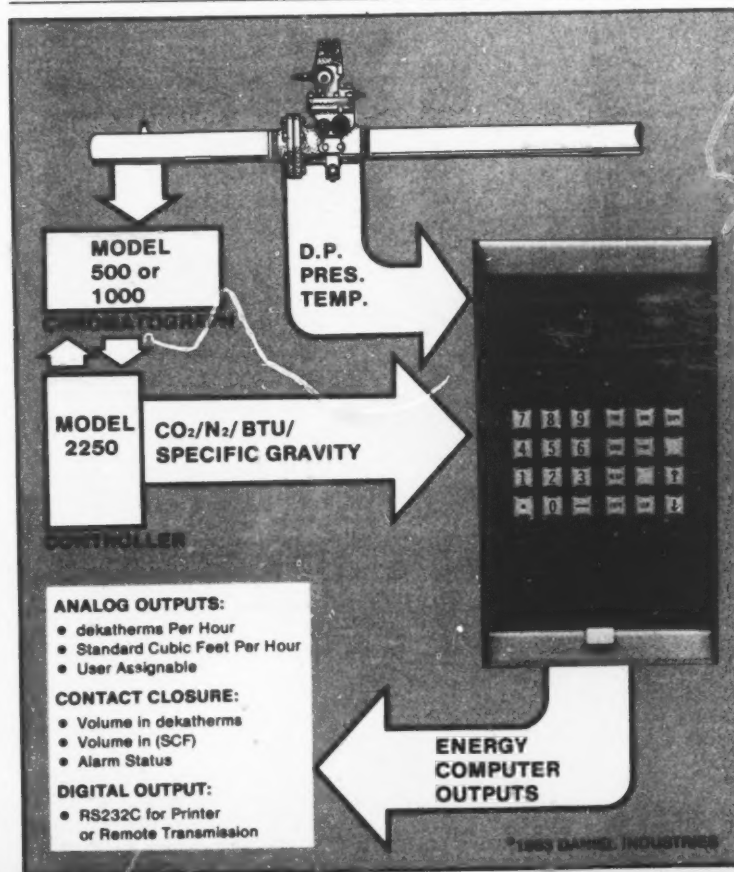
Cortez Pipeline, built by Shell Oil Co., was completed during 1983 and work continued at both ends on gathering and distribution systems. Shell reportedly is studying another major line of about 800 miles of large diameter to transport CO₂ from Cortez to northeastern Colorado, Wyoming, and Montana. Shell has other projects in Mississippi that are temporarily on "hold."

Plans have also been announced for a line to transport CO₂ from Wyoming to the West Coast. Other major activity is centered around West Texas and eastern New Mexico. P&GJ

U.S. — Natural Gas Pipelines

Company	Miles	Size (In.)	From	To	Cost (\$Millions)	Status	Contractors/Notes
Adobe Gas Co.	80	N.A.	Toole, Liberty, and Hill cos., Mont.	Convent, La.		Planned	Ford Bacon & Davis (E)
Air Products & Chemicals	30	10 & 12	Plaquemine, La.	Hanover, N.J.		Planned	Loops
Algonquin Gas Transmission	20	6 & 30	Bridgewater, N.J.	Grand Traverse County, Mich.	25	Planned	
ANR Storage Co.	16	36	Kalkaska County, Mich.	Monroe, La.	90	Planned	Construction begins in spring, completion by winter
Arkla	80	30	Magnolia, Ark.			Planned	Construction in 1985
Celanese Chemical	21	18	Panhandle, Texas	Pampa, Texas		Planned	Construction in late 1984
Central Illinois Light	22		Henry, Ill.	Princeton, Ill.		Planned	Construction in late 1984
Colorado Interstate Gas	36	2-20	Colorado & Kansas		5.1	Planned	
	48	2-8	Texas, Wyoming, Oklahoma, Kansas, Colorado, & Utah		5.2	Planned	Construction in late 1984
Columbia Gas Transmission	25	Various	Ohio, Pa., & W. Va.			Planned	
	26	8	Clay, Owsley, Lee, & Estill cos., Ky.			Planned	
	111	16 & 24	Pennsylvania & Orange cos., N.Y.		72	Planned	
	347	2-26	Ohio, N.Y., Pa., Md., & Ky.			Planned	
	21	20	Monroe county, W. Va.			Planned	
Columbia Gulf Transmission	22	12	Lawrence County, Pa.			Planned	
	4	20	South Pass area, offshore La.		4.8	Planned	Southern Natural, 20% partner
	5	12 & 16	Offshore Louisiana		9.9	Planned	
	10	10	Vermilion area, offshore La.			Planned	
	11	6	Eugene Island area, offshore La.			Planned	
	13	10-16	Ship Shoal area, offshore La.			Planned	
	18	20	Garden Banks area, block 236			Planned	
	128	10, 12, & 30	Eugene Island and West Cameron areas, offshore La.	West Cameron area, block B-624		Planned	Completion late 1985
Consolidated Gas Supply Corp.	8	20	High Island area, offshore Texas		8.1	Planned	With Natural Gas Pipeline Co. of America
	63	30	Canton, Ohio	Ohio River		Planned	
Consolidated Natural Gas	11	30	Ohio		7.8	Planned	
Corpus Christi Oil & Gas Co.	250	24	North Padre Island	Sabine Pass		Planned	Tarpon Offshore Pipeline System
ENSTAR	100	20	Beluga River field	Anchorage, Alaska	70	U/C	Alaska International Contractors/ Southeast Pipeline Contractors—Completion mid-1984
Equitable Gas Co.	35	16 & 20	Greene County, Pa. & Monongalia County, W. Va.		7.3	Planned	1st phase of 3-year program
Faustina Pipeline Co.	100	24 & 30	Enith, La.	Industrial facilities near Baton Rouge, La.		U/C	Holico, R.B. Potashnick, WHC
Florida Gas Transmission	13	12	Putnam County, Fla.		6.6	Planned	
	361	30	La., Miss., Fla.		19	Planned	Loops
Galexis Industries	22	10	Lamar & Fayette cos., Ala.			Planned	
Great Lakes Gas Transmission Co.	21	36	Kalkaska & Crawford cos., Mich.		18	Planned	Bids out 3/84, construction 5/84
High Island Offshore System	380	36	Minn., Mich., Wisc.		425	Planned	
Houston Pipe Line Co.	66	36	High Island area, offshore Texas		101	Planned	
	40	12	Webb County, Texas			Planned	
	66	36	South Texas		13.6	Planned	
Lone Star Producing Co.	28	6 & 8	Offshore Jefferson County, Texas	Offshore Galveston, Texas		Planned	
Louisiana Resources Corp.	14	30	Vermilion Parish, La.			Planned	
	21	24	Cameron Parish, La.			Planned	
Memphis Gas, Light & Water	26	6-22		Memphis, Tenn.		Planned	From proposed coal gasification facility
Michigan Wisconsin Pipe Line	37	20	Woodstock, Ill.	Jamesville, Wisc.	22	Planned	
	68	36 & 42	Iowa		53	Planned	Part of program to replace No. 1 Amarillo pipeline
Mountain Fuel Supply	44	20	Randolph, Utah	Hyrum, Utah	15	Planned	
Mustang Fuel Corp.	30	12	Oklahoma			Planned	Completion in 1984

Company	Miles	Size (in.)	From	To	Cost (\$MM)	Status	Contractors/Notes
Natural Gas Pipe Line Co. of America	120	4-10	Yuma, Sedgewick, & Phillips cos., Colo.			Planned	Gathering lines
	23	6, 10 & 14	West Louisiana & East Texas		13.6	Planned	
	38	26 & 30	Hutchinson & Gray counties, Texas & Beckham County, Okla.			Planned	
	92	4, 5, 10, & 12	Garden, Deuel, Cheyenne, & Morrill cos., Neb.			Planned	
Niagara Interstate Pipeline System	162	36, 42, & 48	Niagara Falls, N.Y.	Leidy storage area, Pa.	417.6	Planned	
Northeastern Arkansas Transmission	24	16	Halls, Tenn.	Barfield, Ark.	8.7	Planned	
Northern Indiana Public Service	11	8 & 12	Indiana		3.6	Planned	Company crews—completion 1984
	25	8, 16, & 30	Indiana		7.6	Planned	Company crews—completion 1985
Northern Natural Gas Co.	120	4-12	Iowa, Neb., & Minn.			Planned	
	69	4 & 8	Minn. & Neb.			Planned	
	39	26	Iowa & Ill.		68.3	Planned	
	27	12	Sprayberry field, Texas		4.5	Planned	Completion in 1984
	13	20	Onshore Texas		7.4	Planned	Completion in 1984
	10	10	High Island area, offshore Texas		5.3	Planned	Completion in 1984
	9	20	Matagorda Island, Texas		11.9	Planned	Deferred until 1989
Northwest Alaska Pipeline Co.	745	48	Prudhoe Bay, Alaska	Alaska-Yukon border	10,600	Planned	Completion in 1984
Northwest Pipeline Corp.	185	30 & 36	Colo., Utah, & Wash.			Planned	Gathering Lines
	175	4-12	Moxa Arch area, Wyo.			Planned	
	80	6 & 12	Lincoln, Uinta, & Sweetwater cos., Colo.			Planned	
	43	22	Ore. & Idaho			Planned	Loops
Northwest Central Pipe Line	31	6 & 10	Kay County, Okla., Sumner & Crowley cos., Kan.		2.9	Planned	2-year program
Nueces Co.	24	4 & 6	Colorado			Planned	
Pacific Gas & Electric	290	42	California		236	Planned	
	112	34	Little Coy Bay, Calif.	Gosford, Calif.		Planned	
Palo Duro Pipeline Co.	240	24	Texas Panhandle	Sweetwater, Texas	96	Planned	
Panhandle Eastern Pipeline Co.	92	4-16	Weld & Adams cos., Colo.		10	Planned	
	60	4-6	Wattenberg field, Colo.		6.9	Planned	
	37	4-10	Woods & Woodward counties, Okla.		6.1	Planned	
	32	8 & 10	Major County, Okla.		4.9	Planned	
	26	6 & 10	Sweetwater County, Wyo.		3.9	Planned	
Quivira Gas Co.	25	18	Eugene Island area, offshore La.	St. Mary's Parish, La.		Planned	
	24	12	Eugene Island area, offshore La.			Planned	
Sabine Pipeline Co.	5	12	West Cameron area, offshore La.		4.7	Planned	Completion by spring 1984
Seagull Energy Co.	163	12 & 24	Brownsville, Texas	Galveston County, Texas		Planned	Seagull Shoreline System—first phase, 55 miles of 24-in. completed 11/83 by Brown & Root Weir Ltd Construction (C)
Sohio Chemical Co.	45	16	Paulding, Putnam, Allen, & Van Wert cos., Ohio		16.42	U/C	
South Jersey Gas Co.	15	20	Cumberland & Atlantic cos., N.J.			Planned	Completion in 1984
Southern California LNG Terminal	63	32	Ventura County, Calif.		9.6	Planned	
Southern Natural Gas	40	18	Offshore La.		10.6	Planned	
	34	10	Carthage field, Texas	Sorrento, La.		Planned	
Southern States Pipeline Co.	32	12	Norco, La.	Arizona		Planned	
Southwest Gas Co.	20	16	Mohave County, Nev.		41	Planned	Shoshone Gas Project, prebuild phase
Tennessee Gas Pipeline	105	10-30	Conn., Mass., N.H., N.J., N.Y., Pa., & Va.		29.4	Planned	
Tejas Gas Co.	32	36	North & west sides of Houston			Planned	With Coronado Transmission
	22	8	Zapala County, Texas			Planned	



THE TOTAL ENERGY COMPUTER

The Model 2231E is a total energy computer for orifice measurement. Inputs to the orifice flow equation for N₂, CO₂, and specific gravity (that normally would be fixed) are available as outputs from the companion Model 2250 Chromatograph Controller. These values, in addition to ΔP , static pressure and temperature, serve as live inputs to the algorithm to solve the AGA-3 orifice equation in the Model 2231E. The BTU value from the Model 2250 is also integrated in the Model 2231E with the orifice flow rate to derive total energy throughput for the system. The Model 2231E is by far the most cost-effective way to solve your total energy measurement problem.

Call your Daniel representative for more information. Or contact the Measurement Experts, Daniel Electronics Division.

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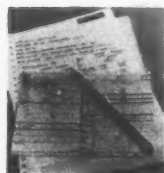
Electronics Division

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Company	Miles	Size (in.)	From	To	Cost (\$MM)	Status	Contractors/Notes
Texas Eastern Corp.	8	30	Perulack, Pa.	Bechtelville, Pa.		Planned	Completion in 1984—Phase one of project to increase volume of gas from Canada
	81	25	Tamarack, Pa.	Perulack, Pa.		Planned	Phase 2—from termination of NIPS
	13	30	Perulack, Pa.	Bechtelville, Pa.		Planned	Phase 3—extension of phase 1 loops
	185	30 & 36	High Island area, offshore Texas	East Cameron area, offshore La.	240	Deferred	With Tennessee Gas Pipe Line
Texas Gas Transmission	13	8 & 12	Chandler area, offshore La.		14.6	Planned	
	13	20	Eunice compressor station, La.		12.7	Planned	
	10	10	Vermilion Parish, La.	Lakeside Mallard Bay, La.		Planned	
	5	12	Roanoke system	Lakeside Mallard Bay, La.		Planned	
Texas International Petroleum Corp.	25	24	Offshore St. Bernard Parish, La.		25	Planned	With Southeast Louisiana Pipeline Corp.
Trans-Anadarko Pipeline System	468	36	Custer County, Okla.	Monroe, La.	487.5	Planned	Phase 1—approved by FERC 11/82
	167	36	Moore County, Texas	Custer County, Okla.	212.5	Planned	Phase 2—deferred
Transcontinental Gas Pipe Line Corp.	230	10-42	Pa. & N.J.			Planned	Loops on Leidy system
	51	42	Allen & Pt. Coupee parishes, La.		48.8	Planned	
	29	12, 16, & 20	Brazos and Galveston areas, offshore Texas		29.5	Planned	With Tennessee Gas Pipeline
	33	20	Matagorda Island area, offshore Texas		27.5	Planned	
	14	10, 12, & 20	High Island area, offshore Texas		23.1	Planned	
Transwestern Pipeline Co.	80	12 & 20	Hemphill County, Texas	Roger Mills County, Okla.	38.1	Planned	
	59	20	Oklahoma			Planned	
	58	8, 10, & 12	New Mexico		10	Planned	
	36	20	Chaves County, N.M.	DeBaca County, N.M.	23.6	Planned	
United States Natural Gas Corp.	55	6, 12, & 16	West Cameron Area, offshore La.	Cameron Parish, La.	7	Planned	
Valero Energy Corp.	43	20	Karnes & DeWitt cos., Texas		25.4	Planned	Phase 1 of a 2-year program
Yukon Pacific Corp.	820		Prudhoe Bay	Kenai Peninsula	2600	Planned	Part of proposal to ship LNG to Japan and the U.S.

U.S. — Crude Oil Pipelines

Company	Miles	Size (in.)	From	To	Cost (\$MM)	Status	Contractors/Notes
All American Pipe Line Co.	1100	30	Bakersfield, Calif.	Midland, Texas		Planned	
Continental Pipeline	12	18	Milne Point, Alaska	Kuparuk Pipeline		Planned	Completion in 1984
DOE	26	36	Nederland, Texas	Big Hill, Texas		Planned	Part of SPR program
Four Corners Pipeline	180	24	California		200	Planned	Bechtel Petroleum (E)
Grand Valley Pipeline Co.	166	16	Southeast Utah	Rangely, Colo.		Planned	
Getty Oil Co.	90	N.A.	Gaviota, Calif.	Bakersfield, Calif.		Planned	
Kuparuk Pipeline Co.	36	12, 18, & 24	Prudhoe Bay	TAPS No. 1 Station	90	Planned	Completion in 1985
Mobil Oil Exploration & Production Southeast	20	4-20	Lower Mobile Bay, Ala.	South Mobile County, Ala.		Planned	5 lines in single ditch
Northville Industries	211	30 & 36	Texas City, Texas	Houston, Nederland, and Freeport, Texas		Planned	Brown & Root (E)
Occidental Petroleum Co.	150	24	Colorado	Wyoming		Planned	Completion in 1985. Will carry shale oil.
Standard Oil of California/ARCO	130-250	N.A.	Offshore Santa Barbara, Calif.	Refineries near Los Angeles	200-300	Planned	Completion in late 1986 or early 1987
Union Oil of California	18	10	East Breaks area, offshore Texas	High Island area, offshore Texas		Planned	Completion in mid-1984



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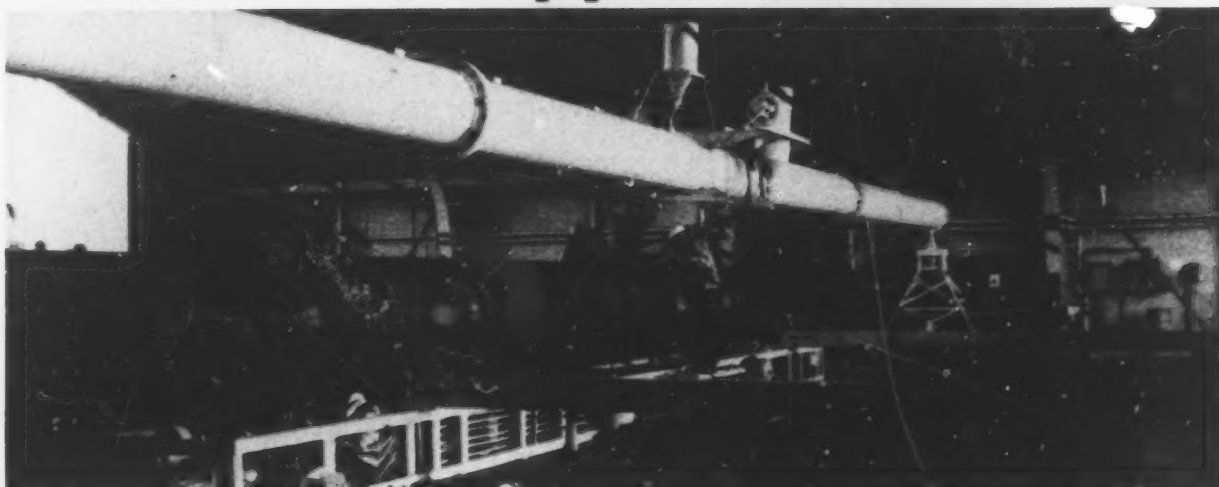
U.S. — Product Pipelines

Company	Miles	Size (in.)	From	To	Cost (\$MM)	Status	Contractors/Notes
ARCO Oil & Gas	31	6	Offshore Louisiana	Onshore Louisiana		Planned	Ford Bacon & Davis (E)
Celanese Chemical Co.	21	18	Texas			Planned	Completion in 1985
Continental Pipeline	88	6	Sherridan, Wyo.	Gillette, Wyo.		Planned	
ENSTAR, Dow Chemical, Shell Chemical	800	16 & 20	Prudhoe Bay	Valdez or Anchorage, Alaska	1200	Planned	
Enterprise Pipeline	23	8	Napoleonville, La.	Geismar, La.		Planned	Dual lines
Exxon Pipeline Co.	18	8	South Louisiana			Planned	
Koch Oil Co.	30	6	Kingfisher, Okla.	El Reno, Okla.		Planned	LPG
MAPCO	41	3	Texas			Planned	LPG
Phillips Petroleum Co.	820	10	Williston, N.D.	Conway, Kan.		Planned	
Quivira Gas Co.	25	6	Eugene Island area, offshore La.	St. Mary's Parish, La.		Planned	
Seagull Products Co.	169	6 & 8	Upper Texas Gulf Coast	Mt. Belvieu & Baytown, Texas	70	Planned	Phase 1, 121 miles, built in 1983
Texas Eastern Co.	130	6 & 8	Longview, Texas	Shreveport, La.		Planned	Ford Bacon & Davis (E&C)
Transgulf Pipeline Co.	890	14, 18, & 24	Baton Rouge, La.	Ft. Lauderdale, Fla.	140	Planned	Conversion from gas service
	80	12-18	Louisiana & Florida			Planned	Laterals to terminals
	12	4 & 26	Florida			Planned	Loops

Canada — Natural Gas Pipelines

Company	Miles	Size (in.)	From	To	Cost (\$MM)	Status	Contractors/Notes
Amerada Minerals Corp.	105	4 & 6	Carstairs	Didsbury-Olds area		Planned	
B.C. Hydro	46	24	Mainland	Vancouver Island	457	Planned	Distribution
	170	8-20	Vancouver Island			Planned	
Bow River Gas Pipelines	20	4 & 6	Southeast Alta., various fields			Planned	
Canadian Superior Oil Co.	25	6-12	Liege field, Alta.			Planned	
Canadian Western Natural Gas	28	24	Beiseker	East Calgary		Planned	
	44	12	Cayley	Fort McLeod		Planned	
	30	12	Lethbridge	Taber		Planned	
	30	12	Taber	Bow Island		Planned	
Canterra Energy Co.	42	8 & 18	South Hanlan field	Blackstone, Alta.		Planned	
	15	10-30	Jarvie storage field, Alta.			Planned	
Centennial Natural Gas Pipeline Ltd.			Mainland	Vancouver Island	577	Planned	
Dome Petroleum Ltd.	545	26	Windsor Creek	Grassy Point, B.C.		Planned	Western LNG project
	85	3-10	West Pembina field			Planned	
	67	3-10	Primrose-Kirby area			Planned	
East Coast Pipe Line Ltd.	1000	36	Sable Island fields, Offshore N.S.	Montreal		Planned	
Foothills Pipe Lines (South Yukon) Ltd.	276	56	Southern Yukon			Planned	
Foothills Pipe Lines (North BC) Ltd.	232	48	Southern Yukon			Planned	
Foothills Pipe Lines (Alberta) Ltd.	444	56	Northern B.C.			Planned	
Foothills Pipe Lines Ltd.	394	56	Alberta			Planned	
	740	34	Whitehorse	Mackenzie Delta	2500	Planned	
	105	36	Southeastern B.C.			Planned	
Gaz Inter-Cite Quebec	249	N.A.	Trois Rivières	Chicoutimi, Que.		Planned	
	87	N.A.	Sabrevois	Sherbrooke, Que.		Planned	
Gaz Metropolitan	379	1-20	Montreal area			Planned	

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Equipment Ownership Reflects Changing Requirements

by Dean Hale, Editor

Construction equipment survey

Notable changes in construction equipment utilization and ownership are taking place within gas distribution utilities. They are being caused by the added replacement, maintenance, and repair—coupled with regulatory constraints.

More than 202,750 units of construction equipment, major tool items, and units of transportation equipment are presently owned by the nation's 1560 gas distribution utilities. While total unit ownership has declined since 1974, the companies are using bigger, more productive equipment and have streamlined their construction operations.

Greater use of plastic pipe for mains and services—up from 51% of all piping in 1974 to 89% in 1983—has meant less need for heavy equipment to handle plastic pipe that weighs much less than steel or cast iron, less need for welding equipment, and reduced need for pipe coating and wrapping equipment.

More versatile equipment, such as the combination front-end loader and trencher or the tractor with front-end loader and backhoe, along with items such as small, portable service line plows have led utilities to operate with smaller crews and less equipment.

Construction Practices

Gas utilities install 42% of their new and replacement mains and distribution contractors install 58%. The utilities install a larger share of the service lines—66%—with distribution contractors installing 33%, plumbers 1%.

Respondents to PIPELINE & GAS JOURNAL'S Construction Equipment Survey serve 23,340,900 customers—48% of the industry total—and these respondent utilities added 231,515 customers in 1982, over 54% of the total added during that year.



Survey respondents installed 43% of the 11,268 miles of new and replacement mains installed in 1982, and 37% of the 12,341 miles of new and replacement service lines installed during that year.

The "mix" on pipe sizes continues to change in the gas utility business, as shown in this table:

1982	1974	1969	1964	1961
62% was 2-in. or smaller	66	55	44	49
34% was 3-in. to 8-in.	31	39	47	42
4% was 10-in. and over	3	6	9	9

Smaller pipe continues to be more widely used. Key reason is that utilities are increasing their operating pressures, automatically increasing the capacity of lines without using larger diameter pipe.

Service lines installed in 1982, by size:

96% was 1½-in. or smaller
4% was 2-in. or larger.

For each new customer added in 1982, gas utilities in the P&GJ survey installed: 102 ft of new main (compared to 86 ft in 1974, 128 ft in 1969, and 129 ft in 1964).

98 ft of new service line (compared to 86 ft in 1974, 84 ft in 1969, and 80 ft in 1964).

Methods and equipment used for various types of excavation for gas mains and services are shown in the accompanying tables.

Equipment Ownership

Gas utilities are major users of construction equipment, specialized tools, and transportation equipment. For example, these utilities own:

- 1 unit of construction equipment for every 1512 customers
- 1 unit of specialized construction or maintenance tool for every 474 customers
- 1 unit of transportation equipment (truck, auto, or trailer) for every 610 customers.

Total tractor ownership by the gas utilities is down about 20% since 1974. The decline has been in both track-type tractors (down 52%) and in wheel-type machines (down 5%). Fewer track-type tractors are being used because more plastic pipe is being installed.

Attachments used on the track-type units include front-end loaders (58%), hydraulic backhoes (26%), sidebooms (21%), and dozer blades (58%). On the wheel-type tractors, 66% are equipped with front-end loaders, 44% have hydraulic backhoes, 7% are fitted with sidebooms, and 8% have dozer blades. Gas utilities are major users of self-propelled forklift units and reported a 141% increase in ownership from 1974 to 1982.

Trencher ownership declined 18% in total numbers, but that's misleading, because much of the decline came in the number of mobile trencher attachments used on tractors, jeeps, and similar vehicles. An increase of 36% occurred in the categories of wheel-type, track-mounted, ladder-type and wheel or truck-mounted ladder-type. Ownership of small, portable, gasoline-engine powered chain-type trenchers declined 23%; many utilities have "moved up" from the smaller one-person, handlebar guided units to one-man riding-type units that are more versatile and more powerful.

The gas utilities also reported a 54% increase in ownership of other excavating equipment, principally backhoes that are crawler-mounted, carrier-mounted, or self-propelled.

How Does Your Utility Compare To The Average?

Ownership on a "miles of main" basis for major equipment categories, based on the P&GJ survey, reveals:

Equipment Item

Tractors
Trenchers
Excavating/Backhoes
Cranes
Pipe Plows
Tampers
Air compressors
Tools (all types)
Welding equipment
Automobiles
Trucks
Trailers

1 Unit Owned For Every

166 miles of main
286 miles of main
280 miles of main
380 miles of main
1452 miles of main
121 miles of main
111 miles of main
8 miles of main
106 miles of main
35 miles of main
10 miles of main
400 miles of main

Ownership of cranes jumped 174% with big increases in self-propelled units, truck-mounted units, truck-bed-mounted hydraulic cranes (up 179%), and self-propelled hydraulic cranes (up 155%).

Pipe plowing remains a popular method of installing both plastic and coated steel pipe, but the number of plowing-in units has diminished by 42%. Vibrating plows remain the most popular type.

Gas company ownership of

pneumatic tampers dropped 47% since 1974, while gasoline-powered tampers increased 137%.

Air compressor numbers dropped 11% since the last P&GJ Construction Equipment Census was conducted, and while the numbers are smaller, the sizes of units owned are much larger. Emphasis appears to have been on replacing older, smaller capacity units with new, larger capacity machines.

(Continued)

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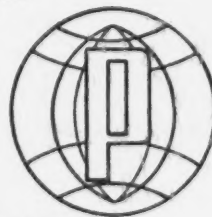
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Who Installs Gas Mains?

Pipe Size	Company Forces	Outside Contractors
2-in. and under	53%	47%
3-in. to 8-in.	42%	58%
10-in. and over	13%	87%
All sizes (total pipe)	47%	58%

Who Installs Gas Service Lines?

Company Forces	66%
Contractors	33%
Plumbers	1%

Tools — pneumatic, gasoline engine driven, pipe handling/cutting/coating and wrapping and other specialized items such as pipe locators, x-ray machines, road boring units, and pipe tapping and plugging machines — have essentially remained constant in total numbers. Changes in the "mix" of such tools reflect changing needs of gas utility construction operations.

Even though plastic pipe has replaced steel and cast iron as the major piping material for gas mains and services, welding is still required for both new and replacement and repair work. Total welding units owned — both a.c. and d.c.

welding generators — decreased only 4%, while the number of oxy-acetylene welding units increased by 12%.

Transportation Equipment

Only a slight decline in the number of passenger vehicles operated by gas utilities was reported — a decrease of 9% in the total. The number of leased vehicles increased from 7% in 1974 to 30% in 1982. Most popular body styles are standard 4-door sedans (27%), compact 4-door sedans (33%), and compact 2-door sedans (14%).

Trucks operated decreased only 1% in total numbers, but the percentage of

Excavation Methods

% of Pipe Installed — As Reported By Companies

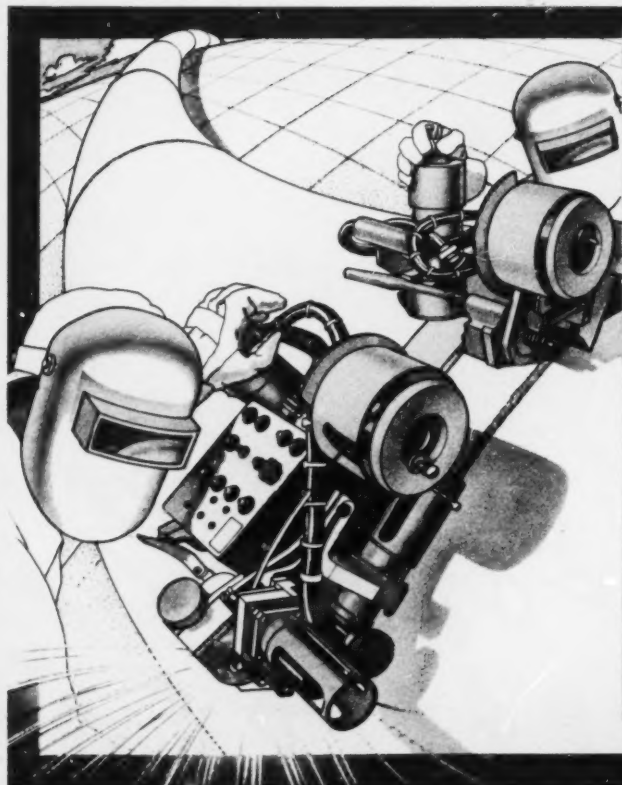
	Bell Hole	Service Lines	Mains to 4-in.	Mains over 4-in.
By hand	4%	6%	1%	2%
Tractor-mounted backhoe	63%	19%	36%	35%
Small portable trencher	5%	36%	16%	7%
Machine trencher (wheel or ladder-type)	7%	9%	17%	20%
Backhoe, self-propelled or truck-mounted	21%	14%	18%	26%
Boring equipment	—	9%	7%	6%
Plowing-in	—	5%	2%	2%
Other	—	2%	3%	2%

leased vehicles rose from 7% in 1974 to 32% in 1982. In size, 69% of the trucks have gross vehicle weight of 10,000 lb or less; 14% have GVW of 10,000 to 19,500 lb, and 17% are heavier than 19,500 lb.

Pickups remain the most popular body style of trucks operated by gas utilities — 41%, followed by closed vans 19%, vehicles with service bodies — 15%, and vehicles with crew bodies — 13%.

Trailer ownership is down 30%. Most popular trailer model is the flat bed — 48% of the total owned, followed by pipe/pole trailers — 26% of the total.

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Oil Companies

Post Higher Earnings

Oil companies posted a modest increase in net income for the second straight quarter.

The 84 companies responding to our survey reported \$8.5 billion in earnings for the third quarter, a 9.5% increase over the same period in 1982. Profit margin for the group rose from 5.1% to 5.5%.

Improved U.S. oil and chemical markets, higher crude oil production, cost-cutting and productivity gains helped Exxon earn 21% more in the third quarter.

Mobil's 42% increase is attributed to substantial gains in foreign petroleum earnings.

Lower financing expenses and corporate overhead, combined with better refining and marketing results gave Sun a 10% earnings rise.

Phillips Petroleum's net income jumped 15% due to higher crude oil production following the acquisition of General American Oil.

Lower crude oil prices and natural gas demand were blamed for the

2% drop in earnings at Shell Oil.

Texaco's net income increased 9% as a result of improved production and downstream earnings.

Standard Oil of Ohio's earnings dropped 11% due to lower income from exploration and production operations, lower crude oil prices, and higher exploration expenses.

Lower operating and administrative costs plus improved productivity paid off for Gulf Oil. Earnings increased 74%.

Standard Oil of Indiana posted

Company	GAS COMPANIES' THIRD QUARTER FINANCIAL REPORTS												Profit Margin	
	Three months ending Sept. 30						Nine months ending Sept. 30							
	Revenues (\$MIL)			Earnings (\$MIL)			Revenues (\$MIL)			Earnings (\$MIL)			1983	1982
	1983	1982	%CHG	1983	1982	%CHG	1983	1982	%CHG	1983	1982	%CHG		
Alabama Tennessee N.G.	28.2	29.6	-4.5	1.3	1.3	0.5	101.7	96.6	5.2	4.4	4.4	-0.1	4.3	4.4
American Nat. Resources	666.2	510.8	30.4	18.8	0.8	2250.0	2393.3	2257.5	6.0	111.1	95.3	16.6	4.6	4.2
ARKLA ¹	257.0	274.6	-6.4	7.7	12.4	-38.3	1306.5	1262.7	3.5	78.2	93.6	-16.5	6.0	7.4
Coastal Corp.	1365.9	1317.3	3.7	24.1	21.2	13.7	4308.8	4218.0	2.2	69.3	43.0	61.1	1.6	1.0
Columbia Gas	765.4	793.1	-3.5	4.5	-15.6		3486.4	3662.9	-4.8	96.9	115.4	-16.1	2.8	3.2
Consolidated Natural Gas	477.4	498.1	-4.2	5.2	6.2	-16.7	2420.8	2327.3	4.0	139.7	118.1	18.2	5.8	5.1
The El Paso Company	1124.1	1067.8	5.3	25.1	32.7	-23.4	3331.2	3175.1	4.9	62.2	72.1	-13.7	1.9	2.3
ENSERCH	886.2	968.3	-8.5	17.3	31.3	-44.9	2680.0	2874.2	-6.8	66.3	124.6	-46.8	2.5	4.3
Houston Natural Gas ²	722.5	728.3	-0.8	26.3	59.6	-55.9	2962.4	3180.7	-6.9	190.2	262.3	-27.5	6.4	8.2
InterNorth	985.9	803.1	22.8	30.1	17.2	74.8	3403.8	2970.6	14.6	164.2	150.5	9.1	4.8	5.1
KN Energy	110.2	109.2	0.9	8.6	4.1	111.7	495.8	484.9	2.2	32.1	24.8	29.1	6.5	5.1
Mountain Fuel Supply ¹	105.7	90.8	16.4	0.4	2.3	-83.6	630.8	526.4	19.9	58.2	37.7	54.3	9.2	7.2
NOVA, An Alberta Corp.	891.0	859.0	3.7	35.0	40.0	-12.5	2880.0	2447.0	17.7	104.0	99.0	5.1	3.6	4.0
ONEOK Inc.	203.5	206.8	-1.6	7.8	-99.4		805.4	833.2	-3.3	20.8	41.6	-50.1	2.6	5.0
Pacific Lighting	1067.3	1027.1	3.9	36.6	22.5	62.9	3415.3	3208.3	6.5	110.8	83.7	32.3	3.2	2.6
Panhandle Eastern	666.0	757.1	-12.0	22.1	48.5	-54.5	2433.1	2506.2	-2.9	110.6	184.5	-40.1	4.5	7.4
Pioneer Corp.	272.6	303.4	-10.2	18.6	26.1	-28.6	779.8	835.2	-6.6	60.2	72.6	-17.0	7.7	8.7
Sonat Inc.	561.6	563.1	-0.3	50.4	48.3	4.3	1988.5	1990.1	-0.1	168.6	160.6	5.0	8.5	8.1
Southern Union Co.	202.1	223.4	-9.5	0.4	0.4	1.4	789.8	817.3	-3.4	18.5	16.1	14.9	2.3	2.0
Texas Eastern Corp. ¹	1300.8	1315.0	-1.1	56.1	43.3	29.6	5517.6	5394.2	2.3	138.1	208.1	-33.6	2.5	3.9
Texas Gas Resources	497.6	650.8	-23.5	23.5	25.7	-8.5	1929.5	2107.4	-8.4	53.1	83.9	-36.7	2.8	4.0
TransCanada Pipelines	775.2	752.0	3.1	57.4	49.6	15.7	2414.5	2567.2	-5.9	160.7	138.9	15.7	6.7	5.4
Transco Energy Co.	797.8	927.7	-14.0	30.0	30.4	-1.3	2850.0	2808.4	1.5	91.7	108.3	-15.3	3.2	3.9
Union Gas Ltd. ³	187.1	159.7	17.2	1.5	-1.3		432.6	368.5	17.4	8.7	4.1	110.7	2.0	1.1
United Energy Resources	843.9	1287.5	-34.5	-18.1	40.6		2976.3	4237.5	-29.8	33.8	159.1	-78.8	1.1	3.8
Westcoast Transmission	193.2	151.5	27.5	15.5	17.3	-10.7	703.2	791.3	-11.1	48.6	55.0	-11.7	6.9	7.0
TOTAL	15954.4	16375.0	-2.6	498.4	572.7	-13.0	57437.2	57948.6	-0.9	2200.9	2557.4	-13.9	3.8	4.4

¹Twelve months. ²Ends July 31. ³Six months.

Third Quarter Report

Company	OIL COMPANIES' THIRD QUARTER FINANCIAL REPORTS														Profit Margin	
	Three months ending Sept. 30						Nine months ending Sept. 30									
	Revenues (\$MIL)			Earnings (\$MIL)			Revenues (\$MIL)			Earnings (\$MIL)						
	1983	1982	%CHG	1983	1982	%CHG	1983	1982	%CHG	1983	1982	%CHG	1983	1982		
Adams Resources & Energy	45.8	46.0	-0.3	0.4	-2.9		134.4	151.5	-11.2	-0.2	-2.7					
Adobe Oil & Gas	41.3	51.2	-19.4	5.6	5.8	-2.7	124.4	154.9	-19.7	16.7	35.3	-52.6	13.4	22.8		
Amerada Hess	2352.8	2124.1	10.8	75.1	80.1	-6.2	6100.8	6277.7	-2.8	148.3	125.0	18.6	2.4	2.0		
American Petrofina	565.1	540.1	4.6	23.0	12.7	81.0	1583.5	1723.3	-8.1	31.9	39.6	-19.4	2.0	2.3		
American Quasar	9.2	12.9	-28.7	0.4	-0.3		29.9	41.4	-27.8	-3.3	1.2			2.9		
Argo Petroleum	5.0	6.0	-16.7	-0.6	-0.6		15.0	17.0	-11.6	-2.3	-1.6					
Asamere	111.5	126.7	-12.0	4.4	4.0	7.6	298.2	350.0	-14.8	0.4	4.1	-89.6	0.1	1.2		
Asland Oil	2147.3	2269.7	-5.4	45.8	49.5	-7.6	6028.4	6700.5	-10.0	40.3	75.9	-46.9	0.7	1.1		
Atlantic Richfield	6378.4	6659.4	-4.2	405.1	446.9	-9.4	19220.8	19895.4	-3.4	1128.8	1242.1	-9.1	5.9	6.2		
Beard Oil	7.6	8.1	-5.6	-0.6	-0.9		23.0	26.9	-14.6	-1.8	-0.3					
Buttes Gas & Oil	31.8	36.0	-11.7	0.4	0.4	8.8	95.9	119.7	-19.9	1.8	1.1	60.4	1.9	0.9		
Callon Petroleum	6.9	4.9	39.6	0.3	-0.2											
Commonwealth Oil Refining	0.9	21.9	-95.9	-4.9	-5.9		18.5	288.1	-93.6	-11.5	-22.1					
Consolidated O & G	9.5	9.1	4.5	0.2	-1.5		28.2	30.6	-8.0	-0.5	-3.8					
Crown Central Petroleum	471.1	450.2	4.6	3.6	8.4	-56.9	1170.9	1279.5	-8.5	-3.9	1.5			0.1		
Crystal Oil	50.7	46.8	8.3	-1.5	1.7		144.8	152.9	-5.3	-2.7	-0.2					
Diamond Shamrock	1014.5	733.2	38.4	39.7	42.3	-6.1	2848.3	2422.0	17.6	73.9	138.9	-46.8	2.6	5.7		
Dorchester Gas	259.5	283.8	-8.5	6.2	3.2	93.4	1369.8	1159.1	18.2	17.7	17.8	-0.9	1.3	1.5		
Dycos Petroleum	11.4	15.2	-24.6	1.8	4.1	-55.6	35.1	43.7	-19.7	6.1	11.9	-49.3	17.2	27.3		
Energy Reserves Group	34.8	39.6	-12.3	2.6	0.1	1861.9	107.8	121.4	-11.2	9.1	-0.2		8.4			
ENSTAR Corp.	74.2	82.8	-10.3	7.2	11.5	-37.1	226.9	262.3	-13.5	20.4	31.0	-34.1	9.0	11.8		
Equity Oil	5.6	5.6	-0.2	1.1	0.2	455.1	16.4	17.3	-5.4	3.3	1.9	75.1	20.3	11.0		
Exxon	23342.0	25203.0	-7.4	1225.0	1017.0	20.5	77165.0	77165.0	-9.4	3360.0	2705.0	24.2	4.8	3.5		
Felmont	20.1	18.8	7.2	4.1	3.8	6.0	59.3	58.0	2.3	10.9	10.8	1.2	18.4	18.6		
Forest Oil Corp.	30.6	40.2	-23.9	2.1	4.7	-54.5	97.0	116.1	-16.4	7.5	9.9	-24.1	7.7	8.5		
Freeport McMoran	194.7	186.1	4.6	26.6	19.7	34.8	585.1	556.1	5.2	67.1	61.7	8.8	11.5	11.1		
Galaxy Oil	3.6	3.8	-6.8	-0.4	-0.5		9.3	10.7	-12.7	1.3	2.0	-31.0	14.4	18.3		
Getty Oil	2939.5	3109.7	-5.5	183.7	182.3	0.8	8965.0	9378.9	-4.4	255.5	518.9	-50.8	2.8	5.5		
Gulf Oil Corp.	7514.0	7547.0	-0.4	276.0	159.0	73.6	21401.0	22498.0	-4.9	681.0	674.0	1.0	3.2	3.0		
Hadson Petroleum	5.1	5.5	-8.8	1.6	2.0		17.0	24.9	-31.7	-11.7	11.2			45.2		
Hamilton Bros. Petroleum	42.0	37.2	12.8	1.9	4.5	-59.0	118.0	126.1	-6.5	12.8	8.9	44.2	10.8	7.0		
Helmerich & Payne	51.8	89.0	-41.8	10.4	18.6	-43.8	184.7	279.6	-33.9	37.2	62.2	-40.1	20.2	22.2		
Hershey Oil	2.1	1.6	36.4	0.2		662.5	5.8	5.2	10.9	0.7	0.4	73.4	11.5	7.4		
Holly Corp.	102.1	100.9	1.2	-0.3	-2.2		341.1	339.3	0.5	4.7	5.1	-7.6	1.4	1.5		
Howell Corp.	34.9	53.3	-34.6	0.4	0.4	3.9	108.8	184.1	-40.9	0.7	1.9	-61.9	0.7	1.0		
Howell Petroleum	13.9	13.2	4.8	1.9	1.5	25.6	51.9	56.9	-8.9	6.4	6.0	6.0	12.3	10.6		
Inexco Oil	42.4	51.5	-17.7	3.0	2.3	9.8	128.4	170.1	-24.5	9.4	14.8	-36.6	7.3	8.7		
Kerr-McGee Corp.	898.3	913.5	-1.7	39.7	56.8	-30.1	2584.4	2762.0	-6.4	101.3	136.2	-25.7	3.9	4.9		
Lear Petroleum	69.1	54.4	27.1	7.0	1.5	360.6	178.2	157.3	13.3	15.7	0.3	6088.1	8.8	0.2		
Louisiana Land & Exp.	313.6	259.1	21.0	24.2	19.2	25.9	877.9	873.9	0.5	75.1	53.1	41.5	8.6	6.1		
Mapco Inc.	540.8	489.6	10.5	13.6	20.2	-32.7	1518.1	1452.2	4.5	38.0	54.1	-29.8	2.5	3.7		
May Petroleum	10.3	7.6	35.6	0.1	-0.2		25.4	22.7	12.1	-1.6	0.8			3.4		
Maynard Oil	6.2	6.8	-8.8	0.7	-0.3		21.7	26.2	-17.4	-1.0	-1.0					
MCO Holding	39.3	43.9	-10.5	0.6	3.1	-80.4	122.6	131.1	-6.5	7.7	9.9	-22.8	6.2	7.6		
Mesa Petroleum	95.0	99.7	-4.7	44.2	29.4	50.2	302.9	303.7	-0.2	97.1	91.2	6.5	32.1	30.0		
MGF Oil	14.0	25.1	-44.5	-19.5	-19.7		47.9	83.4	-42.6	-43.3	-21.8					
Mitchell Energy & Dev.	226.0	239.8	-5.8	20.1	23.7	-15.5	705.0	705.9	-0.1	58.4	57.9	0.9	8.3	8.2		
Mobil Corp.	14200.0	15400.0	-7.8	404.0	284.0	42.3	42900.0	47600.0	-9.9	1056.0	815.0	29.6	2.5	1.7		
Moran Energy	20.5	20.9	-1.5	1.0	0.5	105.6	64.4	74.3	-13.2	3.2	6.4	-50.4	4.9	8.6		
Murphy Oil	565.7	641.0	-11.8	39.8	43.9	-9.4	1894.9	1983.9	-4.5	108.0	119.0	-9.2	5.7	6.0		
Noble Affiliates	73.2	94.9	-22.9	5.7	17.7	-67.6	221.0	317.3	-30.3	18.7	60.4	-69.1	8.4	19.0		
Norris Oil	636.6	695.6	-8.5	-205.3	87.0		2081.5	2032.6	2.4	-147.4	96.5			4.9		
Occidental Petroleum	4908.0	4412.5	11.2	151.8	25.1	504.8	14413.8	12924.5	11.5	320.7	153.6	108.8	2.2	1.2		
Oxoco	12941.2	10467.8	23.6	2282.6	1820.2	25.4	35350.9	26823.4	31.8	6312.9	5252.7	20.2	17.9	19.6		
Pennzoil Co.	587.2	563.5	4.2	34.6	52.5	-34.0	1714.4	1739.4	-1.4	103.3	135.2	-23.6	6.0	7.8		
Petro-Lewis	83.9	78.7	6.6	1.6	2.8	-42.9										
Petroleum Devel.	3.2	4.0	-18.3	-0.1			11.6	10.2	13.4	0.4	-0.5		3.4			
Phillips Petroleum	3890.0	3996.0	-2.7	176.0	153.0	15.0	11316.0	11829.0	-4.3	474.0	491.0	-3.5	4.2	4.2		
Prairie Producing Co.	5.0	6.5	-23.3	0.8	1.3	-35.4	14.4	20.0	-28.2	2.4	3.4	-30.5	16.4	17.0		
Quaker State	226.2	245.5	-7.9	9.3	11.5	-19.4	685.1	718.8	-4.7	27.5	31.4	-12.3	4.0	4.4		
Sabine Corp.	25.1	29.2	-13.9	3.2	-0.9		83.3	83.1	0.2	10.0	0.2	3997.1	11.9	0.3		
Seneca Oil	3.3	4.9	-31.5	2.0	2.6	-21.5	12.2	15.7	-21.9	5.3	4.7	12.4	43.6	30.3		
Shell Oil	5122.0	5090.0	0.6	449.0	442.0	1.6	14638.0	15037.0	-2.7	1084.0	1166.0	-7.0	7.4	7.8		
Southland Royalty	77.7	86.8	-10.5	4.8	7.0	-30.8	239.9	274.6	-12.6	20.0	23.8	-16.0	8.3	8.7		
Southwestern Energy	10.8	12.2	-11.3	1.7	2.1	-19.5	70.7	59.4	19.1	13.9	11.6	19.8	19.6	19.5		
Standard California	7654.0	8666.0	-11.7	509.0	459.0	10.9	21741.0	28056.0	-22.5	1187.0	952.0	24.7	5.5	3.4		
Standard Indiana	7201.0	7677.0	-6.2	584.0	559.0	4.5	22083.0	22400.0	-1.4	1409.0	1411.0	-0.1	6.4	6.3		
Standard Ohio	2995.0	3317.0	-9.7	435.0	487.0	-10.7	8862.0	10313.0	-14.1	1188.0	1415.0	-16.0	13.4	13.7		
Statex Petroleum	3.0	2.5	22.7	-0.5			9.5	9.5	-0.6	-1.2	1.4			14.8		
Sun Co.	3770.0	3950.0	-4.6	167.0	152.0	9.9	11290.0	12160.0	-7.2	392.0	386.0	1.6	3.5	3.2		
Superior Oil	469.7	499.8	-6.0	117.6	39.1	200.9	1345.8	1536.4	-12.4	178.0	199.4	-10.7	13.2	13.0		
Tenneco	3433.0	3631.0	-5.5	144.0	182.0	-20.9	10608.0	11083.0	-4.3	475.0	531.0	-10.5	4.5	4.8		
Tesoro Petroleum	989.4	636.9	55.3	18.1	12.6	43.7	2826.6	2469.2	14.5	48.4	48.1	0.6	1.7	1.9		
Texaco Inc.	10567.0	11833.0	-10.7	331.0	303.0	9.2	30623.0	36312.0	-15.7	977.0	975.0	0.2	3.2	2.7		
Texas American Energy	31.3	38.7	-19.0	-2.1	-1.5		148.1	153.5	-3.6	-0.8	-1.4					
Tosco Corp.	539.4	902.0	-40.2	1.4	22.1	-93.7	2013.1	2552.2	-21.1	-240.2	129.4			5.1		
Total Petroleum N.A.	540.9	553.2	-2.2	11.3	8.3	36.6	1551.7	1649.3	-5.9	-35.1	7.5			0.5		
Union California	2730.0	2770.0	-1.4	180.2	212.8	-15.3	8010.0	8160.0	-1.8	447.9	578.9	-22.6	5.6	7.1		
Universal Resources	10.9	13.9	-21.8	-0.7	1.5		34.7	45.5	-23.8	-2.0	6.7			14.8		
Wainoco Oil	11.0	11.5	-4.8	0.2	-3.3		33.9	37.8	-10.4	1.4	-9.7		4.1			
Wilshire Oil of Texas	2.5	3.4	-27.6	0.4	0.4	0.7	</									

¹Ends Aug. 31. ²Ends April 30. ³Year ends June 30. ⁴Twelve months. ⁵Ends July 31.

5% higher net income due to improved refined product margins and increased earnings from chemical operations.

Lower crude oil prices, higher oil and gas production expenses, and lower petroleum product margins were responsible for Atlantic Richfield's 9% drop in net income.

Occidental Petroleum's third quarter earnings jumped 505% as a result of the acquisition of Cities Service.

Improved refining and marketing margins and lower exploration expenses combined for an 11% increase at Standard Oil of California.

Getty Oil's net income was \$184 million compared to \$182 million in the third quarter of 1982.

Lower sulphur and natural gas volumes translated into a 34% decline in net income for Pennzoil.

Diamond Shamrock's earnings dropped 6% as strong competition in refined product markets kept a lid on profit margins.

Operating income from all three segments of American Petrofina's operations improved in the third

quarter as earnings rose 81%.

Declines in oil and gas operations and contract drilling and trucking subsidiaries caused Noble Affiliates' net income to plunge 66%.

Louisiana Land and Exploration had fewer dry holes plus reduced losses from mining operations. Earnings increased 26%.

Beard Oil reported a net loss of \$635,000 in the third quarter. Earnings were adversely affected by a decline in oil and gas sales and drilling and well servicing revenues.

Continued pressure on refined product margins was cited for the 57% decline at Crown Central Petroleum.

Moran Energy's higher production levels resulted in an increase of 106%.

The 26 gas companies in our survey posted a 13% decline in net income in the third quarter. Profit margin for the group fell from 4.4% to 3.8%.

Consolidated Natural Gas posted a 13% decline in earnings due to depressed conditions in the manufacture and marketing of equipment.

Southern Union reported a \$373,000 loss, as oil refining and marketing continued to be depressed.

Lower earnings and sales volume resulted in net loss of \$18 million for United Energy Resources.

The El Paso Company's net income fell 23% due to lower production volumes and reduced sales to their interstate pipeline.

Improvement in the natural gas pipeline business helped Texas Eastern earn 30% more in the third quarter.

Union Gas earned \$1.5 million compared to a net loss in 1982. Increased gas sales and higher customer rates were the main contributors.

Sonat posted a 4% increase due to adjustments relating to settlements of outstanding regulatory matters and tax issues.

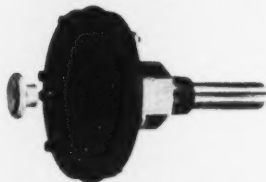
Improvement in Coastal's refining, marketing, and natural gas systems segments resulted in 14% higher earnings.

Columbia Gas System earned \$4.5 million compared to a \$15.6 million loss in 1982. ■

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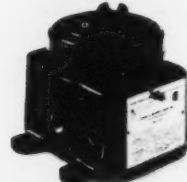


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NAPCA Special Section N1

Complete listing of all Regular, Affiliate, and Foreign Members of National Association of Pipe Coating Applicators, listing their headquarters, facilities, and capabilities, plus a list of domestic and foreign Associate Members. Special maps detail locations of headquarters and plant facilities.

New Life For Old Pipe 19

Seminar on retesting and requalification of older pipelines examines whys and hows of upgrading. Six key operating and engineering managers discuss the subject — the criteria used, the procedures involved.

Encapsulation Quickly Seals Leaking Cast Iron Pipe Joints 22

New technology, developed in the U.K., is helping The Peoples Natural Gas solve the problem of leaking joints in older cast iron distribution systems. Procedure makes possible permanent, economic, and easy repairs.

PE-Lined Pipe Overcomes Wet CO₂ Gas Line Problems 27

Wet carbon dioxide gas can literally eat steel pipe from the inside out. Polyethylene liner is helping solve this problem in an ARCO gathering system.

What's New In Maintenance And Repair Equipment, Materials 30

Many new products, equipment items, and services have been developed for all kinds of maintenance, repair, and replacement work by oil and gas pipelines and gas distribution utilities.

Jungle Pipeline Inspected By Camera Pig 34

Interior of Indonesian gas pipeline carefully checked for heavy oxide corrosion and other problems using special "camera pig" that photographs internal surface of pipe.

Engineered Coating Systems Protect Meters, Station Piping 39

Custom-designed protective coatings used to fight severe fading and chalking as well as abrasion from wind-driven sand on piping, valves, and other equipment at five city gate metering stations.



COVER

Repairing, replacing, and rehabilitating gas mains and service, as well as cross-country pipelines, has become a fulltime big business. Typical gas utility maintenance work is shown being done by Wisconsin Gas crews.

—photo by John W. Alley,
Wisconsin Gas Company

Substantial Drop in Net Income Reported

Fourth quarter earnings for the oil companies responding to Energy Management Report's exclusive survey declined substantially from the same period in 1982.

Net income of \$1.0 billion was reported for the quarter compared to \$3.16 billion a year earlier, representing a 68% drop. For the year, earnings fell to \$12.0 billion from \$20.2 billion in 1982, a 41% decline. Profit margin fell from 3.5% to 1.7%.

Gas companies fared much better during the fourth quarter. Net income dropped slightly from \$439.7 million in 1982 to \$439 million in 1983. Earnings fell 13% for the year, however, from \$2.1 billion in 1982 to \$1.8 billion in 1983. Profit margin for the group fell from 4.8% to 4.2%.

Exxon's 10% increase in net income resulted from higher oil production in the North Sea.

Lower operating and administrative costs and improved productivity helped Gulf Oil earn 31% more during the fourth quarter.

A dry hole at Mukluk off the northern coast of Alaska caused some problems for several companies.

As a result, Texaco posted a 16% decline; Standard Oil of Ohio's earnings dropped 30%; and Diamond Shamrock reported a fourth quarter loss of \$130 million.

Mobil Oil's earnings also suffered from the Mukluk dry hole, but their non-petroleum operations improved, so earnings increased 12%.

Recent weakening of petroleum prices combined with higher U.S. exploration expenses resulted in a 5% drop in net income for Standard Oil of California.

Standard Oil of Indiana posted 11% higher earnings. The increase

was due primarily to greater foreign liquids production, improved refined product margins, and higher earnings from chemical operations.

Lower exploration costs contributed to Getty Oil's 39% increase in net income.

Improvement in Shell Oil's chemical business, increased crude oil production, higher natural gas prices, and improved refined product margins all had a positive effect on net income. Earnings rose 25%.

Sun Company's earnings were adversely affected by a drop in U.S. exploration and production profit. Net income fell 60%.

Lower crude oil prices and increased oil and gas operating and depreciation charges were responsible for Atlantic Richfield's 3% drop in earnings.

Ashland Oil's net income dropped

Company	OIL COMPANIES' FOURTH QUARTER FINANCIAL RESULTS											
	Three months ending Dec. 31						Twelve months ending Dec. 31					
	Revenues (\$'000)			Earnings (\$'000)			Revenues (\$'000)			Earnings (\$'000)		
	1983	1982	%Chg	1983	1982	%Chg	1983	1982	%Chg	1983	1982	%Chg
Amerasia Hess	2,421,305	2,116,414	9.66	57,006	43,613	30.71	6,422,076	6,394,085	0.33	226,147	168,662	34.10
American Petrofina	504,983	530,351	-4.78	23,362	14,835	57.46	2,088,526	2,263,678	-7.33	55,260	54,401	1.58
Anglo Energy	37,683	51,666	-27.06	-19,726	-7,815	152.38	150,340	205,229	-26.74	-82,182	444	-16,609.46
Ashland Oil	2,083,526	2,079,810	0.18	27,186	29,110	-6.61	8,111,985	8,780,339	-7.61	100,369	162,425	-37.67
Callon Petroleum	9,613	5,896	63.08	1,169	-150	-879.33	27,560	20,747	32.91	1,515	349	334.10
Diamond Shamrock	1,177,767	755,339	55.93	-130,331	46,196	-381.48	4,076,107	1,177,379	26.73	-56,163	185,091	-130.34
Durcorch Gas	221,540	409,517	-46.90	2,174	5,613	-61.27	1,181,960	1,340,319	-11.82	14,213	27,975	-20.93
Exxon	24,663,000	26,194,000	-5.56	1,625,000	1,481,000	9.72	94,591,000	131,559,000	-8.66	3,995,000	4,186,000	-19.09
Getty Oil	3,090,993	1,016,766	1.13	216,644	172,445	38.39	12,016,014	17,395,647	-3.06	493,466	690,712	-29.56
Gulf Oil Corp.	1,466,000	8,132,000	-7.94	797,000	226,000	31.42	28,887,000	10,510,000	-5.99	978,000	900,000	8.67
Helmreich & Payne	55,502	81,072	-31.94	10,576	13,516	-21.75	240,209	380,632	-33.19	47,000	76,949	-38.65
Molly Corp.	103,495	112,777	-8.23	1,837	5,445	-66.26	481,643	452,073	16.46	6,523	10,516	-37.97
Texaco Oil	44,854	47,478	-5.52	1,121	4,072	-72.32	173,240	227,538	-20.16	22,556	18,865	19.62
Exxon-Mobil Corp.	973,283	1,019,207	-9.26	17,141	73,515	-76.68	118,412	209,764	-43.05	17,141	73,515	-76.68
Louisiana Land & Exp.	376,401	131,302	13.61	18,900	23,173	-19.44	1,254,756	1,205,175	4.07	94,029	76,262	23.31
Majors Inc.	546,567	540,701	1.08	26,042	19,699	-18.55	2,064,653	1,992,947	3.60	50,427	73,822	-31.62
Mystic Corp.	15,578,000	16,534,000	-5.78	445,000	498,000	-11.61	58,515,000	64,136,000	-8.72	1,501,000	1,213,000	23.74
Murphy Oil	943,044	597,784	-20.17	23,883	18,807	-26.46	2,417,967	2,661,709	-9.39	131,876	157,759	-16.41
Nugget Oil Corp.	139	3,100	-76.18	-761	-204	-282.84	5,161	7,275	-29.19	1,449	-205	-806.83
Occidental Petroleum	4,701,440	2,733,000	-0.66	736,000	3,000	12,200.00	19,157,000	17,657,500	82.58	566,700	155,600	264.20
Penzoil	600,440	574,144	13.60	37,691	50,446	-14.19	2,116,833	2,266,511	-2.13	164,235	186,713	-12.97
Quaker State	217,629	210,144	3.56	9,074	1,216	25.79	802,690	928,933	-2.82	66,574	38,568	55.17
Genesee Oil	1,918	5,792	-32.16	-1,233	-969	-24.93	16,163	21,480	-24.75	-5,569	57,117	-14.90
Shell Oil	5,245,000	5,176,000	1.33	149,000	145,000	25.34	19,893,000	20,214,000	-1.64	1,513,000	1,605,000	-1.74
Standard California	1,441,000	1,887,000	-24.66	407,000	415,000	-1.91	29,182,000	15,943,000	-18.81	1,940,000	1,177,000	55.47
Standard Indiana	7,406,000	7,384,000	0.31	459,000	415,000	10.60	29,499,000	29,753,000	-0.89	1,866,000	1,826,000	2.20
Standard Ohio	1,205,000	1,116,000	-7.94	124,000	444,000	-30.17	10,067,000	11,529,300	-10.81	1,512,000	1,679,000	-10.53
Summit Energy	13,404	12,614	6.27	-1,725	1,726	-135.75	3,913	3,065	27.61	-510	-159	-220.75
Sun	4,336,000	4,104,000	5.17	61,000	111,000	-45.06	15,529,000	16,160,000	-4.55	451,000	537,000	-15.64
Superior Oil	447,485	504,113	-11.23	61,746	74,334	-17.23	1,793,332	2,040,519	-12.11	241,755	223,423	8.21
Tenneco	2,842,000	3,896,000	-1.44	272,000	226,000	25.80	14,448,300	14,974,300	-3.54	644,000	797,000	-13.61
Texaco Inc.	13,303,000	13,390,000	-0.66	396,000	396,000	-14.34	51,100,300	49,300,300	-3.47	2,211,000	1,281,000	73.35
Trask Oil & Gas	447,563	431,089	3.86	79,476	66,524	17.80	1,878,654	1,885,891	-2.37	346,557	261,534	32.13
Tupperware Corp.	16,097,000	13,962,000	14.97	1,181,000	-2,119,000	-145.64	60,724,000	60,167,000	0.93	900,000	-3,501,000	-114.42
Union Corp.	481,064	413,748	17.16	-118,602	1,054	-1,633.37	2,894,700	1,465,946	-76.04	-378,299	122,409	-185.55
Total Petroleum N.A.	528,211	583,772	-10.89	3,914	-5,738	-22.82	2,071,987	2,213,356	-27.01	11,131	12,152	-144.28
Union California	2,841,000	2,736,100	3.73	378,000	370,000	-2.16	15,899,138	15,899,138	-0.00	73,900	694,000	-72.15
Universal Resources	1,665,000	12,595,000	-0.41	15,965,000	-115,000	4,900.00	58,117,000	58,117,000	-18.89	-17,840,000	8,629,000	-274.75
Total	141,468,524	141,532,031	-0.04	1,004,629	3,161,810	-68.23	728,894,871	585,382,943	22.10	17,028,559	22,247,402	-40.60
1 Ends Sept. 30 2 Ends May 31 3 Year and July 31, 1983 4 Six months ending Dec. 31 5 Ends Sept. 31												

1 Ends Sept. 30 2 Ends Nov. 30 3 Year and July 31, 1983 4 Six months ending Oct. 31 5 Ends Oct. 31

ALL COMPANIES' FOURTH QUARTER FINANCIAL RESULTS

Company	Three months ending Dec. 31			Three months ending Dec. 31			Three months ending Dec. 31			Three months ending Dec. 31			Three months ending Dec. 31			Three months ending Dec. 31		
	Revenue (\$000)	Exp. (\$000)	Net (\$000)	Revenue (\$000)	Exp. (\$000)	Net (\$000)	Revenue (\$000)	Exp. (\$000)	Net (\$000)	Revenue (\$000)	Exp. (\$000)	Net (\$000)	Revenue (\$000)	Exp. (\$000)	Net (\$000)	Revenue (\$000)	Exp. (\$000)	Net (\$000)
Alabama Tennessee N.G.	16,080	16,277	-0.54	1,765	1,555	5.94	137,737	132,681	3,65	5,124	5,982	-2.31	4.45	4.50				
Altagasco Inc.	47,080	91,829	-5.72	840	822	3.16	400,429	351,349	13.32	5,261	5,012	4.14	1.56	1.70				
American Nat. Resources	985,000	922,000	17.40	51,000	47,800	6.54	3,372,000	3,091,000	8.48	171,300	161,100	6.33	5.08	5.20				
ARCO	115,283	115,283	-0.83	-8,513	10,166	-187.67	3,297,541	3,295,585	0.07	59,123	95,380	-38.01	4.56	7.36				
Columbia Gas	1,609,394	1,419,070	12.86	67,890	64,618	5.03	5,101,242	5,103,256	-0.04	164,754	160,063	-8.50	1.23	3.53				
ENXCORP. CORP.	827,149	811,433	9.97	-3,011	21,059	-114.30	3,502,365	3,767,675	-7.53	60,760	145,612	-58.27	1.73	3.84				
Entex Inc.	154,987	157,900	-0.81	22,480	13,807	68.04	1,293,143	1,269,291	1.86	63,155	57,134	10.15	4.88	4.52				
Houston N.G. 1	744,075	744,075	-0.53	47,491	58,688	-16.24	2,958,429	3,081,613	-4.00	179,519	249,569	-26.07	6.07	8.10				
Intermountain Gas	16,128	43,234	-16.20	1,760	1,893	-7.02	132,871	149,111	-10.89	4,897	5,449	-10.32	3.76	7.47				
Midcon Corp. 2	637,076	581,464	9.56	MM 614	11,920	-9.28	3,318,975	3,337,430	-0.55	121,605	132,634	-9.11	1.66	3.97				
ONEOK Inc.	297,263	255,422	16.38	14,137	8,113	74.25	1,102,703	1,088,620	1.29	35,761	89,986	-28.46	1.24	4.59				
Panhandle Eastern	972,115	878,116	10.70	41,877	35,368	18.40	3,405,245	3,384,273	0.62	152,438	219,876	-30.67	4.48	6.50				
Sonatr Inc.	735,370	747,598	-1.63	41,608	43,999	-5.43	2,723,881	2,737,696	-0.50	210,273	204,619	2.73	7.72	7.47				
Texas Eastern Corp.							5,393,045	5,654,351	-4.62	154,577	161,334	-4.19	2.87	2.85				
Texas Gas Resources	622,015	627,236	-0.83	26,737	27,399	-2.40	2,262,618	2,304,528	-1.82	79,816	111,266	-28.27	3.53	4.83				
TransCanada Pipelines	1,055,300	999,700	5.61	67,500	60,300	12.50	3,470,700	3,466,920	0.11	228,100	196,900	16.66	5.57	5.74				
Transco Energy	995,000	1,061,000	-6.22	35,500	22,800	55.70	3,845,000	3,869,000	-0.62	133,000	137,000	-2.92	3.46	3.54				
Union Gas Ltd. 3	169,208	182,025	-10.91	19,615	9,536	97.30	801,805	650,525	23.25	27,524	13,669	101.36	3.43	2.10				
Total	10,647,811	10,079,562	5.64	439,000	439,704	-0.20	44,519,729	44,764,086	-0.50	1,859,037	2,134,809	-12.90	4.20	4.80				

1 Ends Oct. 31 2 Ends Sept. 30 3 Nine months

nearly 7% as a result of lower petroleum product margins.

Higher natural gas sales due to extremely cold weather and an increase in sulphur volumes took credit for Pennzoil's 14% rise in earnings.

American Petrofina's net income jumped 57% due to improvement in petrochemicals, production, and exploration segments.

Superior Oil's 166% increase re-

flects generally improved performance for most company operations.

Quaker State Oil Refining reported 26% higher earnings for the fourth quarter due to lower interest cost and taxes.

Callon Petroleum reported earnings of \$1.17 million compared to a \$150,000 loss in 1982. Higher earnings reflect increases in oil and gas sales and production volumes.

Lower crude oil and condensate

prices and volumes, as well as lower natural gas volumes were blamed for Tenneco's 13% drop in net income.

Universal Resources posted a \$7.85 million loss due to a \$6.19 million (after tax) valuation reserve on the company's drilling rigs.

Anglo Energy's fourth quarter loss of \$19.7 million included a provision of \$14.4 million for the loss on the sale of Anglo Resources.

FINANCIAL NOTEBOOK

Consumers should not experience appreciably higher energy costs in 1984, despite an expected increase in oil consumption, according to Bank of America's Quarterly Energy Report.

The improved economies of the U.S., Japan, and Europe will trigger additional demand on the world market, but OPEC is expected to hold its price at \$29/bbl to avoid losses similar to those brought on last year by the cartel's failure to reach an agreement on production.

The report also says the very slight increase in natural gas prices will not keep pace with inflation and in real terms, will actually decline. Permanent reductions in natural gas consumption by U.S. industries are partly responsible for the drop.

Mergers/acquisitions. Exploration Surveys completed the acquisition of Supreme Corp. for about \$10.5 million.

Colorado Interstate (Coastal Corp.) commenced an offer to purchase up to 18.75 million shares of Houston Natural Gas common stock at \$68/share.

Marine and Petroleum Equipment (Nantes, France) acquired

Anglo Marine and Petroleum Equipment (Shreveport, La.).

ANR Technology (American Natural Resources) will acquire an interest in Nu-Tech Industries.

American Petrofina will purchase Champlin Petroleum's service stations/C-stores in 11 southwest and midwest states.

Minden Oil and Gas and Patton Oil agreed to discontinue merger negotiations.

MidCon (Chicago, Ill.) and Texas Oil & Gas (Dallas, Tex.) completed the acquisition of natural gas pipelines and other assets from seven units of Tatham Pipeline (Houston, Tex.) for \$200 million each.

Denver Exploration agreed to acquire Fiesta Energy (Denver, Colo.).

Texaco plans to acquire the U.S. exploration and producing interests of Dome Petroleum (Calgary, Alberta).

Mesa Petroleum and other members of the Gulf Investors Group purchased 675,000 shares of Gulf Oil common stock for about \$1.5 million.

Contracts. Texas Gas Gathering entered into a contract with Sun Exploration and Production to purchase all natural gas produced from a 6,400 acre block owned by Sun in

Crockett and Val Verde Counties, Texas.

Energy and Resource Consultants (Boulder, Colo.) was awarded a \$100,000 contract by Pacific Gas and Electric (San Francisco, Calif.) to analyze the effect of PG&E's Master Meter Conversion program on energy conservation within the utility's service territory.

C-E Lummus (Combustion Engineering) was awarded a contract by FMC Corp.'s Agricultural Chemical Group for the engineering, procurement, and construction of a \$40 million plant expansion for the production of Furadan® in Baltimore, Md.

ISI, Inc. (Barnard and Burk Group) was awarded a contract to provide maintenance services at Chevron U.S.A.'s refinery in Salt Lake City, Utah.

Eastern Associated Coal (Eastern Gas and Fuel Associates) and ADDCO Mining agreed to enter into long-term mineral leases and purchase coal mining operations from Appalachian Power (American Electric Power).

Joint ventures. Brown & Root and a unit of Wharton Williams Holdings joined to form a new Dutch company, Deepwater Holdings BV.

A Royal Dutch/Shell Group com-

AN **HBJ** ENERGY PUBLICATION

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How To Modernize Compressor Stations
How To Cut Unaccounted-For Gas Losses
Soft Excavation Developments

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COVER

Compressor station modernization is focused primarily on reducing fuel cost; P&GJ special report in this issue tells what's happening and how it is working.

—photo courtesy
Consolidated Gas
Transmission Co.

Compressor Station Modernization: The Key Is Cutting Fuel Costs	17
Determining the when, why, how, and how much of compressor station modernization or compressor unit overhaul/rebuilding/replacement is complicated because there are many variables involved; more efficient operation—to reduce fuel expense—remains an overriding consideration, and special P&GJ seminar panel tells why.	

Yes, You Can Control Lost & Unaccounted For Gas	22
Lost and unaccounted for gas represents a big dollar loss to gas distribution utilities and gas transmission pipelines because, in a dozen years, the retail price of gas has increased to over \$5 per Mcf. P&GJ's industry-wide investigation of the problem has uncovered almost two dozen ways to help cut L & U gas losses.	

Rotary Digger, Vacuum Combined For Utility Soft Excavation	30
Accidental damage to buried gas mains and services can be prevented by "soft excavation" techniques, using a new combination of the hand-held rotary digger and the soil removing vacuum method.	

Microprocessor-Based SCADA System Enhances Small Utility's Operations	34
A desktop business computer has been combined with digital telemetry, "smart" microprocessor remote terminal units, pressure, flow and temperature transmitters, and other components to provide a small, widespread utility with fulltime system scanning and logging and alarms.	

Rankine Cycle Heat Recovery Adds 1000 HP In Compression	42
Natural Gas Pipeline Co. of America is using exhaust heat from its regular compressor engines to produce heat for a 1000-hp Rankine cycle turbine engine driving a centrifugal compressor.	

How To Grout And Chock Mount Large Gas Engine Compressors	54
Growth in use of new types of epoxy grout products and applications sometimes makes it difficult for user to select the most suitable product; here's a guide to what's happened and what's happening.	

Onsite Fuel Cell Power Plants Key To All-Gas Energy Services	65
Phosphoric acid fuel cells that convert natural gas to electricity are being field tested in anticipation of the day that the all-gas energy home will include providing power for your TV, stereo, lights, and dishwasher.	

Compressor Station Modernization: The Key Is Cutting Fuel Costs

by Dean Hale, Editor

When the cost of natural gas was less than 25¢ per Mcf, hardly anyone worried about the cost of fuel gas for compressors.

Or how efficiently they operated.
That's all changed.

Fuel cost is a major concern. The high price of natural gas in the field, in the pipeline, at the city gate, and at the customer meter has brought a new awareness. Pipeline operators well know that most compressor stations operating today were designed and built when gas was cheap.

Now they are seeking ways to improve operating efficiency and cut fuel costs. Modernization of compressor stations, including replacing or rebuilding/overhauling individual compressor units, is an attractive answer.

But capital costs are also a major worry. As a result, gas transmission pipeline company compressor superintendents have to juggle both problems to find

solutions. Replacing old prime movers and compressors with newer units costs money . . . lots of it. Modernization may still be the answer.

What's happening in the gas pipeline business isn't mysterious at all. It is simply that the decisions are complicated because of the many variables involved. When PIPELINE & GAS JOURNAL first began examining station modernization, it found some companies replace stations or units all at once, one or several at a time. Other companies have continuing maintenance and upgrading programs to keep everything up-to-date.

PIPELINE & GAS JOURNAL asked six top operating people concerned with compressor operations to participate in a seminar on compressor station modernization and how to do it better. Respondents participating in this seminar are from companies operating 201 compressor stations and a total of 2,665,260 hp. That's 6% of the industry's total number of compressor stations



Dick Bayley
Columbia Gulf
Transmission Co.



John G. Frank
Great Lakes Gas
Transmission Co.



John T. Hood, Jr.
United Gas Pipe
Line Co.



Thomas E. Jacobs
Tennessee Gas
Pipeline Co.



Don Pendelton
Consumers
Power Co.



W.L. Upham
Houston Pipe
Line Co.

U.S. Compressor Horsepower — 20 Largest Companies

Company Name	Horsepower	Stations			
		Total	Field	Storage	Mainline
ANR Pipeline Co.	1,110,000	96	48	10	38
Colorado Interstate Gas Co.	340,000	74	53	3	18
Columbia Gas Transmission Co.	513,525	177	48	27	102
Columbia Gulf Transmission Corp.	477,450	13	—	—	13
Consolidated Gas Transmission Corp.	279,669	63	5	17	41
El Paso Natural Gas Co.	1,400,000	120	63	2	55
Great Lakes Gas Transmission Co.	374,200	14	—	—	14
High Island Offshore System	460,000	1	—	—	1
Natural Gas Pipeline Co. of America	1,142,610	129	44	8	77
Northern Natural Gas Co.	1,110,000	171	116	2	53
Northwest Central Pipeline Co.	350,000	76	35	6	35
Panhandle Eastern Pipeline Co.	928,364	223	148	5	70
Southern Natural Gas Co.	386,690	36	—	1	35
Tennessee Gas Pipeline Co.	1,274,605	65	—	2	63
Texas Eastern Transmission Corp.	1,328,945	98	24	1	73
Texas Gas Resources Co.	490,000	40	1	11	28
Transcontinental Gas Pipeline Corp.	1,091,789	84	43	3	38
Transwestern Pipeline Co.	274,476	210	190	—	20
Trunkline Gas Co.	349,623	24	4	1	19
United Gas Pipe Line Co.	300,000	89	53	2	34

(3579) and 15% of its total horsepower (18,429,171 hp).

Seminar participants include **Dick Bayley**, Supervisor, Compressors, Columbia Gulf Transmission Co.; **John G. Frank**, Vice President, Engineering, Great Lakes Gas Transmission Co.; **John T. Hood, Jr.**, Assistant Superintendent, Compressor Stations, United Gas Pipe Line Co.; **Thomas E. Jacobs**, Compressor Superintendent, Tennessee Gas Pipeline Co.; **Don Pendleton**, Gas Compressor Superintendent, Consumers Power Co.; **W. L. Upham**, Manager—Compressors, Houston Pipe Line Co., and **Dean Nale**, Editor, PIPELINE & GAS JOURNAL.

Seminar questions and responses are:

P&GJ: How do you decide what stations to modernize?

Jacobs: Fuel cost is the biggest item in our operating and maintenance budget. It is important to keep fuel consumption at a minimum. We are adding fuel measurement devices to each engine. We are also adding microprocessor units to control engines. Overall, we plan to either bring units up to date or replace them.

Hood: Age, condition of the equipment, and economics are the basic criteria. Older stations become obsolete and repair parts are either very costly or hard to obtain.

Upham: Cost of fuel is the principal criterion. We make every effort to reduce this cost. Modernization is one approach.

Frank: Decision to modernize is based on three factors. If a major change in flows of gas occurs, operation of station will change, and may require new equipment. If maintenance of equipment at a station caused large amounts of unit downtime, that equipment will be modified or replaced. If energy costs increase, modification or replacement could be justified.

Pendleton: Decisions on stations that will be candidates for improvements are based on amount of improvement needed and operational cost savings that can be realized.

Bayley: Fuel efficiency is our biggest concern. Pipelines must

have stations in operation and they need to do it efficiently. Age and condition are important as they influence efficiency.

P&GJ: How do you calculate probable return on investment vs. operating cost savings?

Hood: Our engineering planning section determines revenue required to support a project, taking into consideration capital cost, depreciation, fixed rate of return (usually obtained from latest rate filing with FERC), income taxes, *ad valorem* taxes, and operating expenses. We apply this computation to existing facilities and to several approaches to proposed new facilities. From the results we find one with lower cost while earning the required rate of return.

Upham: If the station load is improved, and fuel cost is reduced, we expect a return on the investment.

Bayley: Biggest operating cost savings we see would be in improving fuel efficiency of the units. Fuel gas is not going to become cheaper and the savings will pay for the investment.

Frank: We utilize an investment analysis computer model. This model issued to analyze various pipeline investment opportunities such as modifications, replacements, or additions. This allows us to determine a project's internal rate of return, net cash flow, and cost of service. From that we make a final decision.

Jacobs: It involves some difficult economic analysis and everyone does it differently. Analysis gives us choices; we then make a final decision.

Pendleton: Any investment in capital equipment must be justified on need. That need can include, in modernizing existing facilities, potential reduction in operating costs. These reductions are examined and projects that show the greatest improvement are implemented within capital limitations.

P&GJ: How do you decide on replacement vs. rebuilding/overhaul?

Hood: We overhaul reciprocating equipment (new rings, liners,

pistons, bearings, etc.) as needed. We go through a minor or major overhaul on our turbine equipment based on hours running time. Decision to replace equipment is based on the ability of the equipment to do the job it is called upon to do. If the equipment is in a bad state of repair or operating conditions have changed, it may be replaced.

Bayley: Progressive or continuous rebuilding of units has been our objective for a long time. This upgrading is selective to permit the greatest system efficiency.

Frank: Decision is normally based on economics. Considerations are also given to maintenance records, future company plans, and operating costs.

Pendleton: Rebuilding or replacing is always an economic decision. If you can get desired results without replacing equipment, that should be the course of action followed. The same is true when replacement of existing machinery is indicated.

Jacobs: We do continuing maintenance on our units and bring them up to date in planned programs. If all else fails, we consider replacement.

Upham: Our rebuilding, overhaul, and replacement programs are all by design. It goes back to age, condition, and efficiency.

P&GJ: What product improvements have influenced you most?

Jacobs: There have been several. Microprocessor units for controls and data acquisition. Fiber optics. Synthetic oils. We are always looking for products that will reduce wear or usage and provide fuel savings.

Pendleton: Improved fuel efficiency and reduced exhaust emission levels of prime movers have contributed significantly to the decision to modernize.

Upham: Improved gas turbines, improved engine-compressors, better compressor valves, synthetic oils, electronic controls.

Frank: Advances in electronics especially. We've replaced governors on all of our turbine units. Microprocessor units have replaced pneumatic controls on some turbine units. New station discharge pressure controllers have been installed. A new communications system has been installed. Advances in lighting, heating and cooling systems for buildings, and new air filtering systems for turbines have contributed to the modernization decision.

Bayley: Use of fire resistant lubricants and oils in gas turbines has been a major advance. We were an early user of electronic control systems. We still use the original system in our stations for local control.

P&GJ: What future product improvements would interest you?

Pendleton: Further improvements in fuel efficiency and reduced emission levels of prime movers. A reduction in installed cost would be of great interest.

Jacobs: A good means for measuring throughput over the entire pipeline system. We would also like a means of recovering all of the waste heat from jacket water, lube oil, and prime mover exhaust. This heat energy could be sold for process use or used to generate electricity for sale to nearby electric utilities.

Frank: Compressor units with longer intervals between overhauls and greater efficiency would accelerate the decision to modernize. So would advancements in electronic controls and heat recovery systems.

Hood: Station controls and data gathering using microprocessors and programmable controllers.

Bayley: New machines of much more efficient design or equipment that can be adapted to existing machines to improve efficiency and lower fuel costs.

Upham: As more horsepower is required, we'll need more

What Does Compressor Horsepower Cost?

Cost data gathered by PIPELINE & GAS JOURNAL for both mainline compressor stations and for field and gathering system compressor stations reveals a broad cost range—depending on size and type of unit—as well as location, and whether or not it is an addition to an existing facility or a new facility.

Mainline Gas Compressors

Field and Gathering Gas Compressors Installed Cost—Typical Figures

HP	Type of Unit	Total Cost Per Unit	Cost Per Hp
40	Reciprocating	\$48,000	\$1200
100	Electric motor, recip. compr.	120,000	1200
125	Recipr. engine, recip. compr.	111,000	885
200	Recipr. engine, recip. compr.	300,000	1500
1100	Gas turb., centrif. compr.	1,320,000	1200
1100	Gas turb., centrif. compr., with heat recovery	1,650,000	1500
600	Integral engine-compr.	900,000	1500
30	Integral engine-compr.	45,000	1500

Type Installed	HP	Total Cost	Cost Per HP	Compressor Cost Only, Per HP	Compressor Type
Addition	750	\$ 1,176,700	\$1568	\$1037	Reciprocating
Addition	1160	1,028,000	886	555	Reciprocating
New	1500	7,523,000	2280	594	Reciprocating
Addition	2700	8,540,300	3163	1517	Reciprocating
Addition	2700	4,444,000	1646	407	Reciprocating
Addition	3800	2,534,975	687	n/a	Reciprocating
Addition	4000	10,977,000	2744	492	Reciprocating
New	5200	12,212,000	2348	n/a	Reciprocating
Addition	9000	14,400,000	1800	n/a	Reciprocating
Addition	3300	3,444,000	1043	502	Gas Turb./Centrif.
Addition	3300	6,118,960	1854	909	Gas Turb./Centrif.
New	19,000	23,924,410	1029	417	Gas Turb./Centrif.
New	38,000	39,109,791	1259	417	Gas Turb./Centrif.

powerful and efficient machines. That will hasten modernization and replacement decisions.

P&GJ: *When you modernize a station, what does it include?*

Frank: We've replaced controls, alarm systems, communications, and buildings. Governors have been replaced on all turbine engines. Microprocessor controls have been installed on several turbine units. Installation of microprocessor controls changes alarm systems. In the next few years, when several of our stations go unmanned, new communication systems will be needed. Remaining manned stations will have building expansions to accommodate the new remote control system.

New Products That Compressor Men Would Like to See in Next Few Years:

- Complete heat recovery systems.
- Lean burning compressor engines.
- Greater fuel efficiency in engines.
- Lower prime mover exhaust emissions.
- Advanced electronic controls.
- Advances in air filtering systems for turbines.
- System for measuring throughput between stations—that would also provide a better measure of operating efficiency and fuel cost.

Bayley: We usually replace all valves and some controls. We poke around generally to see what needs replacement and upgrading. Alarm and shutdown systems are always kept current.

Upham: We replace what needs to be replaced. It varies greatly from station to station.

Hood: Our modernization involves replacing old equipment such as compressor units, buildings, foundations, and cooling towers. The older equipment is kept in operation until the new equipment is installed and operative. It is then removed.

Jacobs: We will probably replace some controls; unit valves and yard piping valves; the compressor valves, which are internal to the machines; some yard piping if it improves flexibility of operation. We upgrade and test regularly our alarm and shutdown systems. We have already eliminated wooden cooling towers and now use atmospheric units.

Pendleton: Every item in a compressor station is individually evaluated and replaced as needed. Reuse of material and equipment is done whenever feasible and economical.

P&GJ: *What effect do environmental concerns have on modernization decisions?*

Hood: Environmental concerns are generally improved when a decision is made to modernize. The latest, more modern equipment and technology is geared to lower emissions and noise control. We've not had any problems with permitting where a station is modernized.

Jacobs: They have a definite effect on horsepower replacement. New facilities have to meet current environmental codes.

Upham: We always anticipate that there might be a problem, especially if you are modernizing a station that, when built, was

Here's What P&GJ Seminar Respondents Plan to Do in 1984 and Next 3 Years:

Total No. of Stations operated by the respondents companies	201
No. of stations to be modernized in 1984:	15
No. of stations to be modernized next 3 years	31
No. of compressor units that will be overhauled/rebuilt in 1984	9
No. of compressor units that will be overhauled/rebuilt in next 3 years	26
No. of compressor units to be replaced in 1984	4
No. of compressor units to be replaced in next 3 years	16
Estimated expenditures for modernization/rebuilding/overhaul/replacement in 1984	\$12,150,000
Estimated expenditures for modernization/rebuilding/overhaul/replacement in next 3 years	\$37,400,000

in the country and now is close to a town. We do whatever possible to avoid problems.

Pendleton: Environmental requirements must be met whenever new construction or changes occur at compressor stations. Exhaust emissions permitting is stringent in our area.

Bayley: We have made modifications to our compressor stations to meet federal spill regulations that have changed since our pipeline began its operations. A Spill Prevention Control and Countermeasure Plan has been completed for each location. A modified inlet silencer was installed on one aircraft derivative turbine engine to reduce the noise level. We've not had any problems with obtaining permits.

P&GJ: *What trends in compressors and prime movers do you see in 1984 and in the future?*

Jacobs: Most important consideration will be fuel economy.

Hood: Emphasis will be placed on cogeneration and waste heat recovery to generate electricity in conjunction with compressing gas.

Frank: More efficient units. Time between overhauls will be extended. Aircraft derivative units will retain their efficiencies for longer time periods. Large, variable speed electric-driven units in the 16,000-hp range could become economical.

Bayley: There should be a breakthrough in gas turbine efficiency in the very near future. This will involve higher firing temperatures and improved air compression.

Upham: There will be greater emphasis on the lean burning engines.

Pendleton: There will be active efforts to improving thermal efficiency and to lower exhaust emission levels.

P&GJ

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AN HBJ ENERGY PUBLICATION

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Drag Reducers & Flow Improvers
Pump Station Modernization
Santos Liquids Line's SCADA System

PIPELINE & GAS JOURNAL

International Pipeline & Gas Utility Design, Construction & Operation

Published Continuously Since 1859

in this issue

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Exclusive report on the "magic potions" that provide a slick way to increase capacity features high molecular weight polymer being used for many liquids pipeline applications, tells what it is and how it works with details on many applications to date; report also discusses wax crystal modifier additives for waxy crudes and a new emulsion stabilizer used with conventional surfactants for asphaltic crudes.

Pump Station Modernization 22

Increasing operating costs, major changes in supply patterns, need for greater pumping efficiencies are prompting liquids pipelines to modernize or replace pump stations and change operating procedures.

Modular System Monitors Control Pakistan Pipeline 29a

Sui Gas Transmission Co. has installed a new SCADA system on its rapidly expanding gas pipeline system; the microprocessor-based modular system provides continuous, automatic control, status monitoring, and alarm capabilities.

SCADA Makes Operation Possible For Line In Remote, Rugged Area 30

In South Australia, between the Moomba oil field and a storage and shipping terminal at Stony Point near Adelaide, Santos is operating 423 miles of liquids pipeline through some incredibly remote, demanding terrain using a single operator at one control point.

Mini Meter Prover Trials Impressive 33

Part 1 of report on new micro-size liquids pipeline proving equipment used in proving positive displacement flowmeters measuring crude oil and other high viscosity, high specific gravity petroleum products.

Drag Reducer Boosts Line Capacity In Louisiana 37

Shell Pipeline Corp. increased flow through a South Louisiana crude oil pipeline from 130,000 to 145,000 b/d by using a high molecular weight polymer drag reducer; a temporary expedient, it was far less costly than adding pumping horsepower or looping the line.

Nacap Completes La Chiffa Products Terminal In Algeria 39

Turnkey contract involved construction of a terminal with many new features and a 31-mile products pipeline; terminal was installed at site of a wartime fuel storage area, complicating construction procedures.

E/C/S Directory 41

P&GJ's 18th annual E/C/S Directory lists highly specialized engineering-construction-service firms worldwide with the expertise needed to solve difficult engineering and construction problems for pipelines, utilities.



COVER

Dispatching and system control is an important facet of modern liquids pipeline operations; keeping track of tenders enroute, deliveries, and inputs requires the best of both man and machine.

— photo courtesy
Williams Pipeline
Company

Pump Station Modernization

Power Costs, Efficiencies, Changing Supply Prompt Renewals

SPECIAL REPORT

by Dean Hale, Editor

Liquids pipeliners, faced with increasing operating costs and major changes in supply patterns, are modernizing or replacing pump stations at a rapid clip.

During 1984, an estimated 288 mainline crude oil and products pipeline pump stations will be modernized along with 251 crude oil field and gathering stations. Total cost will exceed \$131 million.

U.S. crude and products pipeline companies currently operate more than 193,000 miles of mainlines and more than 96,000 miles of crude field and gathering lines.

Higher power costs (most pipeline stations today use electric motors to drive pumps) have accentuated the search for more efficient station operations.

Pipeliners are finding ways to reduce operating costs. Solutions range from machining centrifugal pump impellers to accommodate a wider range of flows to improved electronic controls. Operating at "off peak" power times cuts electrical power costs but complicates scheduling and flow patterns.

Maintenance costs are getting close scrutiny. Stations with a lot of downtime to repair motors, pumps and appurtenances are early candidates for modernizing or replacement.

Replacement is the ultimate step. Most of the liquids pipeline companies prefer to modernize and upgrade.

To get a better look at what's happening with the liquids pipelines and their pump station modernizing and replacement programs, PIPELINE & GAS JOURNAL asked key operating management personnel at seven major companies to participate in a special seminar on the subject.

These companies (PGJ 500 Rank of 100 leading liquid pipelines) include ARCO Pipe Line Co. (1), Buckeye Pipe Line Co. (11), Continental Pipe Line Co. (15), Mobil Pipe Line Co. (8), Shell Pipe Line Corp. (4), Sun Pipe Line Co. (17), and Texas Eastern Products Pipe Line Co. (22).

Participants in the seminar included:

L.F. Clynych, Manager, Eastern Operations, Continental Pipe Line Co.;

H.L. Crawford, Jr., Vice President, Operations and Engineering, Sun Pipe Line Co.;

R.C. Darwin, Manager, Operations Support, Shell Pipe Line Corp.;

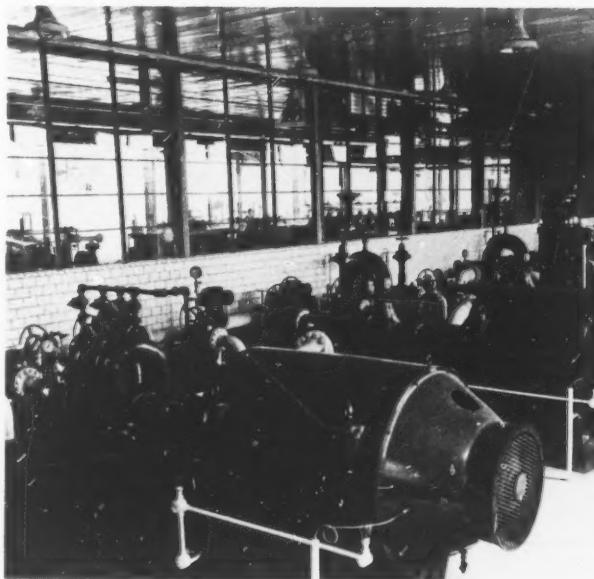
D.L. Dennard, Vice President, Mobil Pipe Line Co.;

George J. Fox, Director, Engineering and Construction, Buckeye Pipe Line Co.;

Gail M. Stout, Senior Vice President and Manager of Operations, ARCO Pipe Line Co.;

John E. Zimmerhanel, Manager, Technical Services, Texas Eastern Products Pipe Line Co., and

Dean Hale, editor, PIPELINE & GAS JOURNAL.



P&GJ's questions and the participants' responses:

PGJ: What's the major reason for modernizing or replacing a pump station?

Dennard: Two reasons. First, a change in throughput, either up or down, to the extent that the station is no longer functional. Second, an older station that is no longer efficient i.e., pumps need replacing or electrical equipment can be improved. Sometimes a new station needs to be built at a different site to achieve hydraulic balance on the system.

Zimmerhanel: We have to look at everything today — maintenance costs, energy costs, and other economic factors.

Fox: Changing capacity requirements and new business. A need to renovate some stations. Power costs.

Stout: If you don't modernize, you cannot continue to be competitive in the PGJ 500 list of Top 100 Liquid Pipelines! We are systematically replacing cast iron pump cases with steel pump cases. We are replacing old controls with new solid state electronics. By mid-1985, we will be all-solid state.

Clynych: Modernization is an ongoing remedial approach. We modernize when equipment is either worn out or obsolete. Some of our control equipment is 20 years old or older and advances in technology make some equipment obsolete.

Crawford: We modernize stations incrementally as a maintenance procedure. We also do it when additional throughput is needed. We will continue to automate stations.

PGJ: How do fuel/energy costs affect the decision?

Stout: Most of our mainline stations are electric and energy costs are a major consideration. Increases in recent years have been very significant. We are always trying to reduce costs.

Fox: Power costs are our number one concern. There are many ways to reduce power costs — optimize throughput, use different combinations of stations, use offpeak power whenever possible, rebates, keep demand level down by limiting



L.F. Clynych



H.L. Crawford Jr.



R.C. Darwin

Here's How Seven Major Liquids Pipeline Companies Plan To Modernize/Replace Pump Stations

	1984	1985-87
Number of stations to be modernized	61	68
Number of stations to be replaced	1	2
Total expenditures for modernization/replacement	\$17.5million	N/A

amount of power being used at any one time, and use curtailable power, which some electric utilities will offer at a discount.

Clynych: Electric power costs are our largest single expense. To overcome this problem, we are using "CDR" drag reducer; we achieve power factor correction with capacitors, especially in rural areas; and we continuously overhaul pumps to keep them up to specifications. We've also had to use reduced voltage starters in areas where full voltage starting cannot be allowed.

Crawford: We are very conscious of energy costs — it is our biggest operational expense.

Dennard: Cost of power is the greatest influence in considering replacements or modernization.

Zimmerhanel: Electrical power costs are a major consideration. We have a few engine-driven stations... less than 10%. The remainder are electric motor-driven.

Darwin: Energy costs are a very large element in the overall cost picture, not including oil losses. Over 90% of our mainline stations are electric. The others have natural gas fueled internal combustion engines as prime movers.

PGJ: What is the trend in pump station prime movers?

Dennard: On our products pipelines, variable speed a.c. motors may be an answer to variations in pumping requirements. On crude pipelines, the trend is operational — make sure impellers are the right size; have enough equipment to move the crude efficiently; and operate whenever possible to take advantage of off-peak electrical rates.

Zimmerhanel: Electric motors dominate the selection. Variable speed drives deserve consideration. You can use either a fluid drive or variable frequency equipment. In some applications, gas turbines may prove economical.

Fox: If power is available, we use electric motor prime movers. From a maintenance standpoint, the electric motor is simple to service. But there is a caveat here — many small rural electric companies cannot provide enough power to start a 1000-hp motor.

Crawford: If cost can be justified, the gas turbine should be considered. Today's electrical motors are more efficient.

Darwin: We are looking at variable speed electric motors and higher efficiency motors.

Clynych: The variable speed a.c. motor is limited to specific applications to solve specific power problems.

Stout: We have some variable speed electric motors in our system. When we buy new motors, we intend to look at them.

PGJ: What is the trend in pump station pumps?

Clynych: Primarily multistage, split case, horizontal centrifugal pumps.

Stout: We are changing impellers to improve efficiency.

Zimmerhanel: Centrifugal pumps — horizontal split case design — remain the most popular.

Dennard: Centrifugals are now universal. The multistage centrifugal can be operated in many combinations for best efficiency.

Darwin: The horizontal split-case centrifugal seems to be the most widely accepted.

Fox: All of our pumps are centrifugals. They are the most adaptable.

Crawford: Centrifugals are now used everywhere.

PGJ: What product improvements have contributed most to your decision to modernize?

Dennard: The variable speed motor has been a real innovation. Microprocessors and the resultant control and data collection systems are important.

Zimmerhanel: Electronics have made a big contribution toward station automation. We use RTUs when upgrading a station.

Darwin: Application of electronics to many functions has given us better surveillance of pipelines and pump stations and better control of both. Electronics has also aided the need to modernize and support instrumentation.

Crawford: Electronics. The new electronic devices have helped reduce maintenance costs and given us greater flexibility. Improved measurement devices. Cost of products is so high you must have precision measurement and control. Computers make retrofitting possible and the use of computers adds a higher level of sensitivity.

Fox: Computerization of remote controls. Microprocessors, which have many, many applications.

Clynych: Automation for stations. We are installing or replacing remote terminal units with "smart" RTUs. With these, data is processed on-site and minute-to-minute adjustments are made automatically without the central dispatcher being involved.

Stout: Significant technological development has occurred in solid state controls. High speed, smaller meter provers with excellent accuracy have been an important development.

PGJ: When you modernize a station, do you replace yard piping? Valves and actuators? Local controls?

Fox: We do not replace yard piping unless it is of the wrong configuration or is bare pipe that needs coating and cathodic protection. Valves are not generally replaced but are retrofitted with motor operators. We regularly change out local controls. Most of them were pneumatic. We now use electrohydraulic systems.

Stout: We revise yard piping to permit isolating the mainline from the station for safety. We try to keep piping above-ground and, on our product pipelines, we try to eliminate traps that spread interfaces. Valves and valve actuators are updated as necessary.

Zimmerhanel: We replace yard piping, valves and actuators, and local controls as necessary.

Total Liquids Pipelines — Mainline & Gathering Pump Station Modernization/Replacement Estimates

	1984	1985-87
Number of mainline stations to be modernized	288	475
Number of mainline stations to be replaced	7	12
Number of field gathering stations to be modernized	251	417
Total expenditures for modernization/replacement	\$131 million	N/A

Darwin: Changes in yard piping are made on a location-by-location basis. Depends on condition, proper sizing, pressure drops, and complexity. Changes in valves and actuators will also depend upon the situation. We like to replace actuators with newer, more reliable operators. We do not change for the sake of changing.

Clynch: Normally we do not replace yard piping. We check it annually and sometimes we rearrange for better operation. Valves and actuators are updated. We have replaced a lot of station valves.

Crawford: Depending on condition we might replace yard piping. It is not mandatory. Valves and actuators are replaced as needed depending upon the situation. Automation of a station would affect the decision. Upgrading local controls depends on the game plan — we usually do.

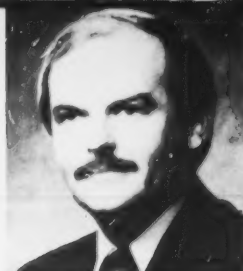
Dennard: We look at piping for integrity, function, and the ability to operate remotely. Replacement of valves and actuators depends on age of existing equipment and applications. Only our key stations are manned — stations with complex piping and a lot of metering. Stations are equipped to operate locally when it is desirable to do so. Local controls are upgraded as necessary.

What Liquids Pipeliners Want In New Products/Services...

- Anything that improves efficiency, or reduces fuel or power costs.
- Further developments in variable speed electrical motors — over and above what is available now. Further refinement in control valves and actuators and their applications.
- Better leak detection systems.
- Energy conservation improvements in the equipment used. Safety and environmental control are very important and anything that improves these areas is of real interest.
- A power optimization program that really works.
- Better commercial communications capabilities. The break-up of the Bell system has created problems. It is now difficult to get service, especially on weekends.
- A reliable, positive interface detection system to enable switches to be made accurately at stations as batches change — and to be able to do it remotely.
- Prime movers and pumps with increased efficiency and a better payout.
- Better supervisory control systems.



D.L. Dennard



G.J. Fox



G.M. Stout



J.E. Zimmerhanel

PGJ: What type station buildings do you have and what do you build now?

Darwin: We have all kinds of stations, and the type generally depends upon the age. Oldest stations are of the closed, masonry type. Newer ones are open-air with a canopy.

Clynch: 99% of our stations are open-air design.

Dennard: We have all three types. The area of country where we operate helps determine what type of station we use. While most are open-air, those in the cold country are partially sheltered. Again, when we move a station down the line to achieve hydraulic balance the new station is usually open-air.

Stout: We have all types. We do not remove buildings unless absolutely necessary. All new stations are open-air. We spend quite a bit for noise abatement at our stations, and find that being good neighbors is quite contagious.

Zimmerhanel: The majority of our stations built recently are of open-air design. Most older stations were built with a shed over the pumping unit. A few were enclosed in buildings.

Fox: There's no rule on station types. Most older ones are of the closed-type design, and we keep them unless there is a good reason to change. For the last 15 to 20 years, we have built partially sheltered stations. More recently we have built open stations with a small building to house controls.

Crawford: We have all kinds; another type depends on the age. All of our new stations are open-air with a canopy.

PGJ: How does maintenance cost influence modernization and replacement?

Clynch: Maintenance costs are a primary reason for modernization or replacement. "Too costly" or "no longer functional" are key reasons.

Darwin: Maintenance is certainly a part of the total decision. If older equipment is not supported by the manufacturer and is constantly rebuilt, you have to consider replacement.

Dennard: Maintenance is where one of the biggest potentials for savings that exists today. It is better to replace a station that is too costly to maintain than to keep a costly maintenance program.

Stout: With a system as large as ours, maintenance costs have an impact and it can strongly influence the modernization or replacement decision.

Fox: If maintenance becomes a big cost, the station becomes a candidate for modernization.

Crawford: We keep very detailed records of station maintenance. It is an extremely important consideration. **F&GJ**

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Repair Renovate Replace



Renewing America's Pipelines

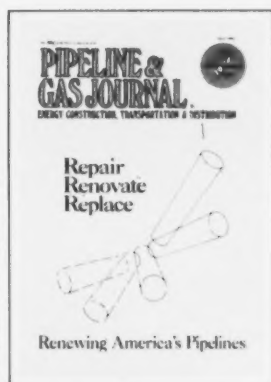
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International Pipeline & Gas Utility Design, Construction & Operation

How do you best illustrate, in an abstract manner, the meanings of "repair/renovate/replace"? Presentation Editor James Duke, taking a clue from the CAD (computer aided design) folks, produced this eye-catching design involving a rotating joint of pipe that hints of "aging" via dashed lines.



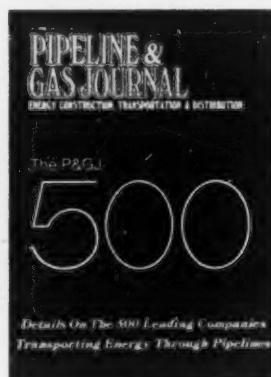
ON THE COVER:

Repair/renovate/replace is not the same as the 3Rs you learned in school, but it is an educational process that's fast becoming standard in the world of energy pipelines; in this 125th anniversary issue of P&GJ, the editorial staff crunches out some hard fact stats that cannot be ignored, and assesses the situation as it stands today.



Page 14

Only report of its kind on the U.S. energy pipeline industry, The P&GJ 500 is a unique overview of the structure of the nation's pipeline/gas utility network. An important tool for planners, analysts, management, and engineers, both as a reference and a benchmark, it profiles the top 300 gas distribution utilities, the top 100 gas transmission and gathering pipelines, and the top 100 liquids pipelines.



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Four of the oldest gas distribution utilities in the U.S. are among the strongest and most up-to-date in terms of outlook for the future.

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Time to Renew

America's energy pipeline system grows older every day. The nation's vast network of oil and gas pipelines and gas distribution utility mains and services has had tremendous growth in the nearly 40 years since the end of World War II. About half of all energy piping now in operation has been installed in the past 25 years.

The other half goes far back in time. It includes many miles of lines built in the 1920s and 1930s, and even some cast iron mains that are more than 100 years old.

This aging is of continuing and vital concern to the pipeline and gas utility industry. As the piping system has reached a point of maturity and demands for new "expansion" facilities have diminished in recent years, companies have found it necessary to channel increasing funds for replacement of older, less efficient lines. Today's budgets for construction reflect that — often more money is dedicated to replacement than new installations.

Of the estimated \$9.7 billion that the U.S. energy pipelines will spend in the next 12 months, PIPELINE & GAS JOURNAL estimates that 50% will be used for the 3Rs — repair/renovate/replace.

America's energy pipeline system now totals 2,018,052 miles. That includes 1,346,025 miles of gas mains and services; 394,407 miles of gas transmission and gas gathering pipelines; and 277,620 miles of crude oil trunk, crude oil gathering, and refined products pipelines.

Approximately 44% of the gas mains and services are more than 25 years old; 49% of the gas transmission and gathering lines are more than 25 years old; and 53% of the liquids lines are more than 25 years old.

The aging is not uniform. As shown on accompanying regional data maps and charts, some areas have relatively new gas utility systems and old pipelines, while others have old gas systems and newer pipelines. Some areas, in total, are younger overall than others. The vintag-

ing of the piping systems often reflects the population growth and economic development of the regions over time.

What's wrong with these energy pipelines? Nothing. But, like our human bodies or our homes or our cars and trucks, they require more upkeep as they get older.

That upkeep also costs more. Maintenance and repair is expensive in today's congested world, one that is getting more congested all the time. Sometimes it is cheaper to replace a facility than to repair or renovate it.

Maintenance is good. Operating companies have consistently maintained their pipeline and utility systems. Their standards are tough. They have a strong obligation to protect the public. They also have enormous investments to protect. They must deliver energy efficiently. That demands that the system be kept in first class condition.

Thus, an increasing larger share of budgets goes for maintenance, repair, and replacement.

Gas distribution utility companies, for example, follow up and quickly fix reported leaks. These companies firmly believe that safety is a prime objective and they operate that way.

Liquids and gas pipeline companies, even where they have pipeline systems strung out over miles and miles of remote areas, constantly check and patrol their pipelines and use sophisticated equipment to detect even the smallest glitch in the operating system.

Pipeline safety legislation enacted by the Congress in 1968 has established minimum performance standards and helped

the small, marginal operator improve operating practices.

Data accumulated by the Department of Transportation in the 15 years since the pipeline safety legislation was enacted indicates that the industry has an outstanding record.

Pipelines are safest. Pipelines are the safest of all transportation modes. Pipelines transport roughly 60% of the nation's energy supply.

In 1982, according to DOT, there were 1,711 gas pipeline "failures" and 200 liquids pipeline "failures" reported. Remember — that's for more than 1.74 million miles of gas lines and 277,000 miles of liquids lines. That's only one failure per 1,017 miles of gas line and one failure per 1,385 miles of liquids lines.

Even more important — more than 60% of those failures was caused by "damage by outside forces." Being around energy pipelines is a lot safer than riding in your family automobile or taking a bath in your home.

(A "failure" is a leak, no matter how small, that is repaired, and includes "damage by outside forces," generally when third party contractors — such as sewer and water contractors or highway builders or maintainers — damage buried lines because of negligence.)

Repair/renovate/replace. There is no escaping from the 3Rs if pipeline systems are to be maintained in first class condition. Repair of systems is frequently on a priority basis. Leaks, when found, must be repaired immediately. Conditions that could become hazardous are next on the priority list.

Renovation and replacement take more time to plan and execute. Each must be accomplished with skill and a knowledge that the procedure and materials involved are adequate and proper for the job. Each is expected to produce long-term results.

Renovation generally involves upgrading of an existing facility, such as internally coating joints of an older cast iron main or internally cleaning and coating — in-place — an existing steel pipeline.

Replacement is a final step. It may involve a procedure such as renewal by insertion of a plastic pipe inside an older, in-place steel or cast iron main, or installation in another location of a completely new pipeline or gas main that will result in the abandonment and non-use of an existing line.

SPECIAL REPORT

by DEAN MALE, Editor

ENERGY PIPELINE MILEAGE IN THE U.S.

AREA	Gas Mains	Gas Services	Gas Trans. Pipelines	Gas Gath. Pipelines	Crude Pipelines	Crude Gath. Lines	Product Pipelines
Northeastern	147,397	116,991	27,903	16,035	2,683	6,692	8,453
Southeastern	148,000	43,858	39,888	4,283	2,583	2,541	8,695
North Central	239,935	148,951	82,447	13,750	21,547	16,958	38,759
South Central	149,605	59,378	119,675	45,252	44,315	59,173	30,204
Northwestern	48,664	23,510	19,364	10,234	7,444	4,996	6,140
Southwestern	88,552	82,579	14,629	947	6,541	4,808	5,088
TOTALS	870,758	475,267	303,906	90,501	85,113	95,168	97,339



Repair
Renovate
Replace

What will be required? Obviously, wholesale replacement or renovation of older facilities — just because they have grown older — is neither required or desirable. No one is really certain just how long any particular type of installation can last. There are, though, guidelines that provide age ranges when facilities are no longer economic to operate or maintain, and these point the way toward renovation or, ultimately, replacement.

If only 1% of our total pipeline energy system were replaced each year, it would involve 20,100 miles of replacement pipe. To keep the total system at 50 years of age or younger, about 2% — or 40,200 miles — would have to be replaced each year. Currently, only about 12,000 to 13,000 miles are being replaced.

That's not enough. The industry's challenge will be to double or triple the annual replacement mileage.

"Infrastructure renewal" programs by municipalities and other government agencies will create many new problems for gas utilities and for oil and gas pipelines in the next couple of decades. As water and sewer facilities are renewed, along with streets, bridges, and highways, the demands for utility line relocation will be enormous. Such relocations are in addition to normal 3R programs and, conceivably, could eat away at available budgets. (A comprehensive seminar-report on this subject appears in the PIPELINE & GAS JOURNAL November 1983 issue, page 18.)

Energy system renewal extends beyond piping. Pump and compressor stations have much shorter life spans and must be renewed sooner. So do control and communication systems, meters and measurement facilities, storage tanks, peakshaving plants, and a great variety of other facilities. Nothing escapes the 3Rs.

Time to renew. Without adequately planned programs, the U.S. energy, pipeline industry will have systems that are ailing from leaks, inadequate capacity, inability to handle today's operating pressures, and just generally poor physical condition.

Without exception, the gas distribution utilities and the oil and gas pipeline companies contacted by PIPELINE & GAS JOUR-

NAL in preparation of this report said they are very aware of the aging of their systems and are planning for renewals and replacements to resolve future problems.

These companies are the leaders in their respective areas of the pipeline energy business and comprise the PGJ 500 list of 300 top gas distribution utilities, 100 top gas pipelines, and 100 top liquids pipelines.

In the total energy pipeline industry,

GAS DISTRIBUTION SYSTEM DATA

What Causes Leaks:

Corrosion	40%
Construction or material defect	20%
Other	40%

Where Leaks Occur:

Mains	43%
Services	42%
Other	15%

Locations Of Leaks:

Pipe	60%
Valves	3%
Fittings	13%
Drips	1%
Regulators	3%
Taps or tap connections	3%
Other	18%

Leaks — By Age:

1970-Date	13%
1960-1969	10%
1950-1959	16%
1940-1949	11%
Before 1940	50%

Materials Of Construction:

	Mains	Services
Steel	76%	74%
Cast Iron	8%	negl.
Copper	negl.	3%
Plastic	16%	23%

Mains By Size:

1-in. or less	5%
1 to 2-in.	49%
2 to 4-in.	28%
4 to 6-in.	11%
8-in.	4%
10-in.	1%
12-in.	1%
Over 12-in.	1%

Mains And Services By Date Of Installation

	Mains	Services
1970-1983	28.8%	32.6%
1960-1969	27.7%	22.8%
1950-1959	16.5%	17.3%
1940-1949	5.2%	6.4%
Before 1940	21.8%	20.9%

GAS TRANSMISSION AND GATHERING SYSTEM DATA

What Causes Leaks:

Damage by outside forces	41%
Construction or material defect	38%
Corrosion	15%
Other	6%

Where Leaks Occur:

Transmission lines	97%
Gathering lines	2%
Other	1%

Locations Of Leaks:

Body of pipe	49%
Girth weld	6%
Longitudinal weld	20%
Compressor	1%
Valves	2%
Tap connection	4%
Fittings	8%
Other	10%

Materials Of Construction:

	Transmission Lines	Gathering Lines
Steel	99%	96%
Plastic	1%	3%
Other	—	1%

By Age:

	Transmission Lines	Gathering Lines
When Installed		
1970-1983	20.4%	24.0%
1960-1969	28.6%	12.1%
1950-1959	27.3%	27.6%
1940-1949	10.0%	9.7%
Before 1940	13.7%	26.6%

Transmission, Gathering Lines By Pipe Size:

1-in. or less	negl.	26-in.	6%
1 to 2-in.	4%	30-in.	12%
2 to 4-in.	11%	34-in.	1%
4 to 6-in.	10%	36-in.	4%
8-in.	10%	40, 42, over 42-in.	1%
10-in.	6%		
12-in.	9%		
14-in.	1%		
16-in.	7%		
18-in.	2%		
20-in.	7%		
22-in.	2%		
24-in.	8%		

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port to Congress on federal-state pipeline safety programs recommended that DOT be given more funds for more inspectors to meet its goal of comprehensive annual inspection of all pipeline operators. GAO has also recommended that interstate pipelines maintain quality assurance programs. It is apparent, in reading GAO's recommendations, that GAO is not knowledgeable about how major interstate pipeline companies operate. They already have their own quality assurance programs. Intelligent, efficient, profitable operation requires such programs.

The problem is not with the larger and efficient operators.

Where the federal-state pipeline safety program breaks down is in comprehensive jurisdiction over – and inspection of – small municipal gas utilities and small pipeline operations (generally intrastate) that are not monitored or are just barely recognized.

There is also a problem of the "master meter" installations (estimated at 27,400) under DOT jurisdiction. These "operators" are neither fish nor fowl. They certainly are not gas utilities. But they do represent problems in safe operation. At present they get little if any inspection or attention.

Of the 39 states with liquids pipelines, GAO found, 17 states are not interested in assuming any jurisdiction over the pipelines. Of the remaining 22 states, 14 have the necessary state legislation to regulate safe operation, and 8 have requested it. **Renewal, Resolve, Regulation.** Renewal certainly has become a major concern of the bulk of the companies who operate the nation's pipeline energy system.

The increasing amount of capital expenditures budgeted for repair/renovate/replace programs is indicative of the resolve these organizations have to keep their systems in the highest operating order.

Expanded federal regulation in this area could only serve to impede progress in renewing the pipeline energy system. If federal regulation is to be an effective force in making renewal viable, its efforts must be directed to those areas where no jurisdiction and very little desire for improvement now exists.

The best solution will come when the "average age" of the energy pipeline system no longer becomes a bigger number each year and, instead, begins to move downward.

Gas Industry Full Partner In America's Energy Future



by O. C. DAVIS,
*Chairman, American Gas Association, and
Chairman, MidCon Corporation.*

It's an exciting time to be a pipeliner. Exciting because natural gas, thought by many a few years ago to be a fuel of the past, is now being recognized as an energy resource with an established importance to America's future.

Today, natural gas pipeline systems across America are moving beyond traditional repair and maintenance activities into renovation and expansion of existing lines and the construction of new gathering and transport systems. This effort will maintain the priceless national asset represented by our current million-mile pipeline system.

In fact, America's abundant supply today and the supply outlook throughout North America holds tremendous potential for the natural gas industry.

The natural gas industry is now undergoing a transition marked by increasing supply, moderating price, and growing demand. It is a transition that has demonstrated to producers, pipelines and distributors the critical importance of working together to assure that natural gas plays the major role it should in the nation's energy future.

Progress in our industry over the last three decades has been impressive. For example, in the early 1950s, only one transmission company had as much as 7,500 miles of in-service transmission pipeline. Today, a dozen companies exceed that operating mileage, and earnings in these companies have increased comparably. The link between the growth of the pipeline industry and the service it

provides to the public is not coincidental. Through research and experience vast improvements have resulted in construction and operations. Equipment and pipeline materials have been greatly improved. All of this resulted in a record for safety and reliability that likely is not equaled in American industry.

Pipeline load capacities have been expanded to provide a transport capability of 23 Tcf versus the 5 Tcf transported in the early 1950s.

Compression energy for pumping of natural gas has more than tripled in this period to more than 17 million horsepower. Underground storage capability, which is vital to economic and efficient operation of the nation's natural gas pipeline system, has expanded to more than 6 Tcf, or better than 25% of the annual sendout.

Natural gas pipeline companies have significantly enhanced the economic progress of our nation. This is evidenced by an increase of gas utility customers over these last 30 years from 26 million to more than 46 million customers.

All of this has been accomplished by pipeline companies meeting their responsibilities to consumers through voluntary agreements negotiated among pipelines, suppliers and their customers, subject to regulatory approval. The current flirtation with mandatory carriage, if written into law, would restructure the gas industry and create pricing problems for consumers while adding another unnecessary layer of federal regulation.

As we approach the mid-point of the decade, the natural gas industry is as vibrant as it was 30 years ago. New technological advances continue to be made; traditional domestic supply potential appears to be adequate well beyond the end of this century; prices are stabilizing well within competitive limits; and marketing opportunities nationwide are improving. The well-being of our industry over these broad fronts is important to the economic and social health of our country.

For the near future, the natural gas industry predicts that capital requirements of the industry from now to the year 2000 will approach \$300 billion. Of this amount, more than a third will be dedicated for pipeline and utility construction and maintenance. As such, the nation's natural gas pipelines are committed to the task of assuring that gas energy continues to be a full partner in America's energy future.

Research Key To Safe, Efficient Energy Pipeline Operation



by **GEORGE H. LAWRENCE**,
President, American Gas Association

The nation's natural gas distribution and transmission companies are engaged in ambitious programs to assure the continued efficient and safe operation of America's million-mile gas energy pipeline system.

The American Gas Association addresses pipeline research through its Pipeline Research Committee activities, which are independently funded, and through the Association's Operating Section programs.

A.G.A.'s Pipeline Research Committee plays a key role in its developmental and applied research programs aimed at optimizing all technological aspects of the natural gas transmission industry. For more than 30 years the committee has sponsored a variety of important research projects. In 1984 more than \$3.5 million is being spent on pipeline research programs. The committee is recognized internationally for the results and conclusions derived from its research.

Research projects currently being funded by the Pipeline Research Committee include stress corrosion cracking, physical process and metallurgy, and full-scale testing. Other important research areas include environmental aspects and safety considerations for field operating personnel. Offshore and arctic research areas will require added expenditures as deeper water depths are explored for gas production. Studies are now in process to evaluate pipeline integrity, vertical pipelay, and stability for on-bottom flow

conditions for water depths surpassing 3,000 ft.

Two recently completed pipeline research projects covered the ultrasonic detection of girth weld defects in shielded metal arc welds and the evaluation of acoustics as a test medium to determine whether source and signature of the signal could identify and classify pipeline anomalies.

The Pipeline Research Committee also has improved operations of underground storage reservoirs, two-phase flow and the long-range implementation of possibly using pipelines for the commercial transmission of hydrogen.

The Operating Section of A.G.A., which is concerned with engineering and technological aspects of the gas industry, provides a unique forum for formulating an industry consensus to respond to proposed state and federal initiatives affecting gas operations. In addition to interfacing with many scientific, trade, and government organizations, the Section sponsors an annual Transmission/Distribution Conference where approximately 1,200 participants take part in the dissemination of

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information on technological advances for all facets of gas company operations.

A major project involving most of the Section's committees is the development of the Gas Engineering and Operating Practices series, a five-volume publication covering the broad spectrum for technical aspects of gas supply through the end use of gas.

Natural gas pipelines deliver directly from the wellhead the most efficient, cleanest and most economic fuel to the nation's 160 million gas users.

Today, the U.S. has an abundant supply of domestic natural gas that can be delivered to these consumers and used to strengthen the nation's economy while reducing America's dependency on foreign oil.

Natural gas in the U.S. and around the world is well positioned to make a growing long-term contribution to the energy mix.

The gas industry is committed to maintaining, rebuilding and renewing the priceless national asset that America's unique pipeline delivery system represents in order to best serve current and future gas consumers.



	Gas		Gas Trans. Pipelines	Gas Gath. Pipelines
	Mains	Services		
1970-1983	23.3%	27.0%	10.0%	16.8%
1950-1969	49.4%	50.7%	65.0%	52.0%
Before 1950	27.3%	22.3%	25.0%	31.2%

	Gas		Gas Trans. Pipelines	Gas Gath. Pipelines
	Mains	Services		
1970-1983	28.3%	33.4%	23.7%	52.0%
1950-1969	56.8%	54.8%	65.6%	42.5%
Before 1950	14.9%	11.8%	10.7%	5.5%

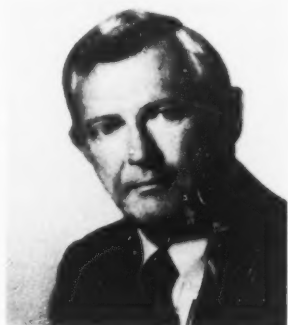


	Gas		Gas Trans. Pipelines	Gas Gath. Pipelines
	Mains	Services		
1970-1983	21.8%	27.1%	11.6%	31.7%
1950-1969	56.7%	50.7%	72.9%	16.2%
Before 1950	21.5%	22.2%	15.5%	52.1%

	Gas		Gas Trans. Pipelines	Gas Gath. Pipelines
	Mains	Services		
1970-1983	20.8%	25.5%	9.7%	36.3%
1950-1969	46.4%	46.9%	63.1%	46.4%
Before 1950	32.8%	27.6%	27.2%	17.3%



Nation's Gas System Is In Overall Excellent Condition



by **TAYLOR G. HOLLAND**
*President, Mississippi Valley Gas Company,
and Chairman, Southern Gas Association*

Two facts must be kept in mind in any discussions of pipeline safety: one, the gas industry is its own most vigilant watchdog, and two, the number one cause of pipeline damage is careless digging by third parties, not deterioration. In the most recent report by the Department of Transportation, 61% of pipeline accidents were caused by damage from outside force.

It is, of course, in the industry's best interest to monitor the soundness of its systems. At today's prices, "unaccounted for" gas can be a major expense. The economic benefit to consumers of careful pipeline maintenance is at least matched by the economic benefit to the industry. Proper and prolonged functioning of pipeline systems — their compressors, regulators and meters — all demand an ultra-clean product; and the product demands an ultra-secure transmission system for most efficient distribution.

It is standard operating procedure at Mississippi Valley Gas to inspect and record the condition of pipe anytime a section is uncovered. And, throughout the industry, when exposed lines are examined inside and out, the most common observation by far is that the pipe is in excellent condition.

A number of factors contribute to the overall excellent condition of the nation's gas distribution system today. First of all, the normal life of a gas field is far less than the life of the gathering lines. Then, too, a substantial part of the transmission sys-



SOUTH CENTRAL AREA

	Gas Mains	Gas Services	Gas Trans. Pipelines	Gas Gath. Pipelines
1970-1983	24.9%	23.6%	16.5%	47.2%
1950-1969	43.8%	38.0%	58.9%	29.2%
Before 1950	31.3%	38.4%	24.6%	23.6%

tems in operation today were built in the 16 years since passage of the Pipeline Safety Act, and do meet the high standards required under that act.

And, finally, advancement in technology has been a major factor in effective pipeline maintenance.

Mississippi Valley Gas was a pioneer in the development of cathodic protection, now an engineering standard nationwide. Modern construction methods and techniques, and new, superior materials also have helped in building more secure systems.

Contrary to a common assertion, increasing commercial and residential development around existing transmission systems actually increases the safety factor. Relocations, expansions in capacity and other changes required by such build-up enhance safety. In addition, the margins between actual operating pressures and design ratings of the pipe also must be increased.

What, then, are the conclusions? The same ones we've all been working with for years: technically and actually the nation's gas pipeline transportation system is generally in excellent condition; the largest problem is still damage by third parties, not deterioration. Major emphasis by government regulations — and the industry — should be preventive information. "Call Before You Dig" should be required.

In Mississippi, as in some other areas, there now is a one-number "Call Before You Dig" center that will help prevent third-party damage to all underground utility lines.

The nation's gas system — gathering lines, long-distance pipelines and local distribution systems — still comprise the safest of all energy transportation methods.

Such preventive measures and requirements as "Call Before You Dig" will make gas lines even safer.

Proven Techniques Ensure Safe Gas Delivery Systems



by **ROGER A. YOUNG**
*President, Bay State Gas Company and
Chairman, New England Gas Association*

The 32 distribution companies and the pipelines that operate in the six New England states, as individual companies and, cooperatively through The New England Gas Association, are continuously monitoring and upgrading their natural gas delivery systems.

Based on firm, top-management commitment, to provide uninterrupted gas service 24 hours a day, 365 days a year, gas distribution departments utilize proven techniques to ensure safe, underground delivery gas systems.

Corrosion is carefully monitored and controlled through cathodic protection... continuous leak survey work by individual utility crews supplemented by professional technical consultants... the growing use of plastic for many applications that are proving cost effective and safe... the development of new efficient equipment to reduce paving time... improved trenching operations... new cost-effective clamps... much more effective internal sealing processes... these are examples of the ongoing effort by the New England natural gas industry to improve its underground systems at lower cost.

Education is a key element in maintaining system integrity and, through NEGA, personnel in all levels of the operating and distribution departments attend work-

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shops, schools and seminars to improve their technical ability.

The NEGA Pipeline Safety Act Liaison Committee is a national leader as it works closely with DOT to assist in the development of new pipeline safety regulations and to suggest amendments that would improve existing regulations.

Public education is a key part of the New England industry's program. Each year, public safety announcements are delivered to 23 television stations and 230 radio stations to inform the public of proper safety precautions. Recently, more than 2 million "scratch-n'-sniff" bill stuffers were purchased, cooperatively, through NEGA. Prevention of damage to underground facilities by contractors and the public, in general, is of key concern to all segments of the population. Bill stuffers covering the "dig-safe" program were included in every telephone bill in five of the New England states and were included in every electric bill in the sixth.

Individual utility distribution maintenance programs provide a firm basis for the safe operation of underground gas systems. Continuing education, a deep involvement in understanding and developing pertinent local, state and federal regulations and top management's total commitment to safety combine to make today's gas energy network safe.



NORTHEASTERN AREA

	Gas Mains	Gas Services	Gas Trans. Pipelines	Gas Gath. Pipelines
1970-1983	14.8%	19.0%	10.9%	12.9%
1950-1969	43.9%	41.8%	51.3%	16.6%
Before 1950	41.3%	39.2%	37.8%	70.5%

Pipelines Environmentally Desirable, Strategically Secure



by **H. T. CHILTON**,
Chairman, Association of Oil Pipe Lines, and
President and Chief Executive Officer
of Colonial Pipeline Company

Liquid petroleum pipelines are almost as old as the first commercial discovery of oil. In 1862, a pilot model pipeline was constructed from a producing well on the Tarr farm near Titusville to a field refinery 1,000 yd away in the Pithole Creek field. After several entrepreneurs failed in efforts to build longer lines, Samuel Van Syckel completed the first commercially successful oil pipeline Oct. 7, 1865. It was a 32,000-ft, 2-in. wrought iron line that was lap-welded with screw-threaded joints and transported 81 bbl of crude per hr from Pithole City, Pa., to the Oil Creek Railroad Station about six miles away.

Today, the U.S. has the largest, most technologically advanced and most cost-efficient crude oil and refined petroleum products pipeline transportation system in the world. This system provides the nation with the safest, most dependable, lowest cost, most environmentally desirable and most strategically secure means by which crude oil and refined petroleum products can be transported.

The U.S. oil pipeline industry operates more than 225,000 miles of crude oil gathering and trunk lines and petroleum products trunk, lateral and delivery lines. More than \$21 billion has been expended constructing this vast transportation network that provides the nation with arteries of steel delivering vital petroleum energy.

The system is, without question, cost beneficial to consumers, providing transport of liquid hydrocarbons at exceptionally low price. This is perhaps best demonstrated by the fact that the nation's oil pipelines move about 23% of all U.S. intercity freight, but at a price that constitutes less than 3% of the nation's total intercity freight bill. In 1982, the most recent year for which data are available, this system transported an estimated 570.5 billion ton miles of crude oil and petroleum products, a very far cry indeed from Van Syckel's 81 bbl/hr pipeline.

Oil pipelines have built a solid reputation for safe operation designed to protect the public, employees and the environment. Their safety record is unparalleled.

Oil pipeline companies use many measures to assure continued safe operations. Rights of way are under constant surveillance by aircraft and other means. Public awareness programs are conducted to reduce third-party damage. Cathodic and other protective measures are used to prevent corrosion at critical points, such as road and rail crossings. Line pressures are monitored both by computer and by highly skilled and trained operators and dispatchers ready to take appropriate action should anything by amiss on a system. Constant repair, renovation and replacement programs are conducted to assure continued failsafe operations and the most technologically advanced system available.

This industry, which has grown under light-handed regulation utilizing private capital and which has given the nation this efficient, low-cost, dependable and safe mode of transportation, is not, of course, without its problems.

A major goal of the Association of Oil Pipe Lines, for example, is to avoid costly and burdensome fetters of excessive federal government economic regulation of the nation's 146 interstate oil pipelines.

Unlike gas pipelines or electric transmission systems, oil pipelines are not monopolies. Oil pipelines are not federally certificated or franchised, but rather are free to enter any market with a new pipeline. They are competitive with one another and with other modes of transport. They are also high-risk ventures which must deal with ever-changing markets.

Their efforts for regulatory reform have substantial support from the private sector, from the Administration and from federal government agencies.

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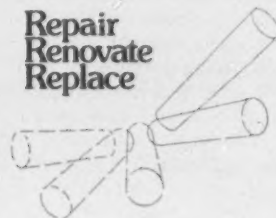
New Ideas, New Techniques Keep Pioneer Utilities Industry Leaders



Even in the early 1900s, Brooklyn Union emergency vehicles carried the latest in modern technology.

by JIM WATTS,
Assistant Editor

**Repair
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One hundred twenty-five years ago, when the first copies of the first issue of this magazine were coming off the press in New York City, Americans in many cities had been enjoying the benefits of gas light for many years. The first gas company in the U.S., and the second in the world, had been chartered in Baltimore, Md., in 1816 and began operations in 1817. Growth in the business was rapid. The July 1, 1859, issue of THE AMERICAN GAS-LIGHT JOURNAL listed 183 U.S. gas companies, from Adrian, Mich., to Zanesville, Ohio.

In those days, gas was made from coal or wood and contained about a third of the heating value of natural gas. Gas was considered useful only for lighting street lamps and home fixtures.

The gas distribution industry has grown over the years to where it can provide reliable, clean-burning energy for any number of applications. It is vigorous, it is vital, and it has made a significant contribution to the standard of living we enjoy today.

But the industry did not go from there to here along a well-marked path. It took people of vision and strong backs to build the nation's energy network. It is going to take even more foresight and hard work and money to keep the system operating in an efficient, modern manner.

To see how it was done and how it is being done, PIPELINE & GAS JOURNAL examines four of the nation's pioneer utilities:

Baltimore Gas & Electric Co.,
Boston Gas Co.,
Brooklyn Union Gas Co.,
and Washington Gas Light Co.

Oldest Utility Stays Modern

BALTIMORE GAS & ELECTRIC CO.

Service Area: The city of Baltimore and all or parts of none surrounding counties, for a total gas service area of approximately 600 sq miles.

Number Of Meters: 513,970

Pipeline Supplier: Columbia Gas Transmission Corp.

1983 Gas Sales: 86 Bcf

1983 Operating Revenues: \$545 million

1983 Capital Expenditures: \$20 million

For more than 167 years, the citizens of Baltimore have been well served by Baltimore Gas & Electric Co. and its predecessors. The first city in the U.S., and the second in the world, to enjoy the benefits of gas energy continues to benefit from the operations of a modern, vigorous gas distribution system.

Chartered in 1816, the parent company of Baltimore Gas lighted its first street lamp in Baltimore at the intersection of Market and Lemon streets Feb. 7, 1817. For the next 117 years, numerous gas companies competed for customers — there were 11 in the city during the 1880s — and the construction in a street of two or even three mains owned by competing gas companies was not uncommon. The Consolidated Gas & Electric Light Co. of Baltimore was formed in 1933, and from that evolved the modern Baltimore Gas & Electric Co.

Being part of a combined utility — one offering gas as well as electric energy — makes a significant difference, said J. T. Wellener, manager of the gas supply department.

"A combination utility has a different way of looking at things," Wellener said. "Electricity and gas are natural competitors in the home market, but we don't try to compete with electricity for the residential customers. A high industrial load is where we make our money.

"Of course, we have an obligation to give our residential customers the best service that we possibly can, and we will always do that," he said.

Wellener said Baltimore Gas is much more interested in the large industrial customer.

"In our marketplace, the gas company has very limited potential for growth," he said. "If we have a balanced load factor — if we can use our system more efficiently — all our customers will benefit."

Another advantage of a combined utility is more efficient use of personnel. The company's distribution and construction forces were reorganized in 1973 and combined with the electrical division as electric lines were moved underground. Mains and lines sometimes are laid in the same trench.

"We combined all forces for the economy of sending one crew to do two jobs," Wellener said. "We've had quite a bit of success."

Of the company's 4,265 miles of main, 1,200 were installed prior to 1940. Much of the system consists of cast iron or steel mains, with a large number of copper services which are being replaced with plastic lines. Plastic inserts also are being used to rejuvenate some of the older cast iron lines, a process Wellener said is working very well in Baltimore.

Most maintenance and repair work is done by company crews, but construction projects usually are contracted out.

"We find that contractors will do a fine job if we have an adequate inspection effort," Wellener said. "We like 'fixed lid' contracts, because it's easier to watch a contractor in respect to price than it is to keep an eye on productivity."

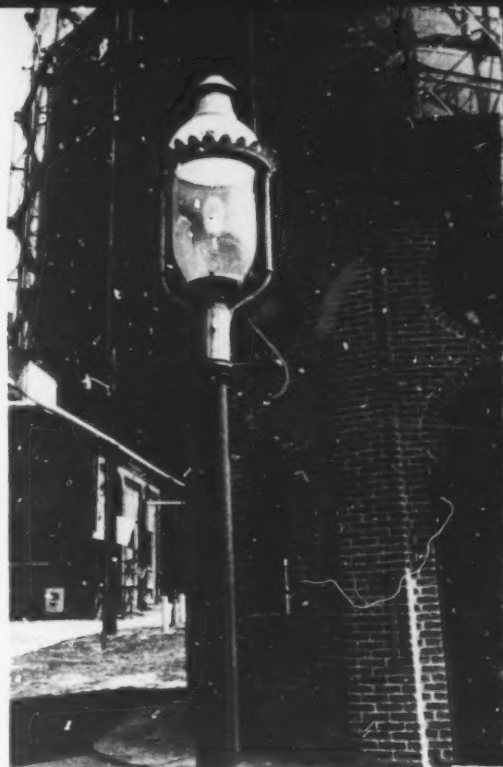
One of the biggest aids to increasing the company's efficiency has been the use of simulation modeling, Wellener said. Baltimore Gas uses the system developed by Stoner Associates, Carlisle, Pa.

"It's a revolution in networking," Wellener asserted. "In the old days, you might have 12 ideas about how to solve a problem, but it was too expensive and time consuming to examine them all. Now one person can get most of the information in an hour."

A "very good leak survey department" has helped Baltimore Gas keep down its lost-and-unaccounted-for gas, Wellener said.

"We have a tremendous record on unaccounted-for gas," he said. "We simply don't tolerate any exposure of our customers to a hazard."

Many older systems are plagued with joint leaks, but Wellener said the unbroken use of oil fogging in older segments has kept the extensive cast iron system in good shape and relatively leak-free. Ethylene glycol fogging now is being



Antique Wellsbach lamp stands near restored 1860s valve station at Baltimore Gas Spring Garden works.

substituted, he said, and is "doing a slightly better job" than the oil fog.

A drastic drop in industrial load experienced in 1982 was virtually overcome through a special program in 1983. A special tariff, establishing delivery service for customer-owned gas, allows industrial and large commercial customers to buy gas at the wellhead and have it transported through Columbia Gas Transmission Co.'s pipelines to Baltimore and then to their facility. Twenty of the company's largest industrial customers already have contracted for gas at the wellhead.

In addition to its pipeline supply and gas from underground storage that it buys from its pipeline supplier in the winter, Baltimore Gas has three peakshaving facilities.

The SNG plant at Sollers Point can produce 60 MMcf/d of gas from naphtha. On-site storage consists of four 150,000-bbl floating roof naphtha tanks and two 60,000-gal. propane tanks.

Propane for peakshaving is provided by the Notch Cliff propane air plant and the Crane storage facility at Seneca Park. A 6-in. pipeline delivers the propane to the plant, which also can receive propane by truck. The storage site has capacity for 6.2 million gal. of propane in an underground cavern. The propane air plant can send out 90 MMcf/d of gas with a heating value of 1,030-1,400 Btu/cu ft.

During the summer Baltimore Gas liquefies pipeline gas at its Spring Garden facility and stores it in three tanks with a combined capacity of 12 million gal., or approximately 1 Bcf. The LNG facility has a rated sendout of 187 MMcf/d.

Boston Gas Fuels New England

BOSTON GAS CO.

Date Operations Began: 1822

Service Area: The city of Boston and 73 surrounding communities, for a total area of slightly more than 1,000 sq miles.

Number Of Meters: 479,000

Number Of Employees: 1,725

Pipeline Suppliers: Algonquin Gas Transmission Corp. and Tennessee Gas Transmission Corp.

1983 Gas Sales: 83.8 Bcf

1983 Operating Revenues: \$568 million

1983 Net Income: \$37 million

1983 Capital Expenditures: \$12 million

Boston Gas Co., the nation's second oldest gas utility and New England's largest, provides clean burning gas energy to almost half a million customers in 74

towns and cities through a network of more than 5,600 miles of main.

Boston Gas' direct ancestor began operations in 1822, manufacturing coal gas for street illumination. Natural gas was introduced 131 years after gas began lighting Boston's streets.

Natural gas was gradually added to the coal gas beginning in 1953, according to John T. McKenna, senior vice president for operations, before going to 100% natural gas in 1960.

"We took it in a series of stages," McKenna said. "We went from 530 Btu to 610 Btu to 640 Btu, then 800, 900, and finally 1,000 Btu." McKenna said the gradual process was used in the interests of safety.

"Our system was very old at that time," he said. "The lines had been laid by eight different companies, sometimes four or five mains in the same street, plus we had to give our servicemen time enough to convert all the gas burning appliances."

Operating an older system in an urban environment requires strict attention to leak control, corrosion, and safety, said Anthony J. DiGiovanni, vice president for distribution and engineering.

"We have many miles of low pressure distribution lines," DiGiovanni said. "About 75% of our system is low pressure." DiGiovanni said drying out of portions of the low pressure system has been a problem, and in other areas the gas is still oil-fogged to keep a tight seal on the older joints. However, he said, by far the biggest threat to the system is accidental dig-ins by contractors.

In an attempt to ease that problem, Boston Gas began pushing for a state-wide "one-call" accident prevention program in the 1960s. By the early 1970s, the private, non-profit Dig-Safe system was implemented in Massachusetts.

"It's not as effective as it should be but we think it is helping us protect our lines," said McKenna. "Still, about a third of the

July 1984
From one old-timer
to another, Happy
125th Birthday.



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This space for address only

PIPELINE &
GAS JOURNAL

LNG tanks hold pipeline gas liquefied during the summer by Baltimore Gas for use as winter peakshaving.

contractor dig-ins are a result of not notifying the system. It's mandatory, but there are few penalties."

Another safety effort is an intensive gas leak detection program, according to DiGiovanni.

DiGiovanni said more leak-detection surveys are carried out each year than are required by the state and federal codes, with flame ionization detector-equipped trucks being used heavily. Surveys are more frequent in the winter and near major construction projects, he said, and the level of odorant is higher than required so leaks will be more apparent to customers.

In an effort to cut the volume of lost and unaccounted-for gas, Boston Gas has a policy of installing only temperature-compensated meters. At a rate of 25,000

conversions per year, all of Boston Gas' meters should be temperature-compensated by the mid-1990s, McKenna said.

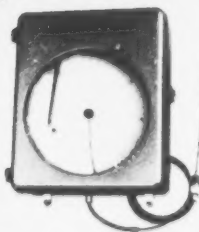
"In addition, we're trying to do a better job of checking the transmission line billings and converting them to Btus," he said. "We use therm billing on all purchases and all sales."

Although Boston Gas' supplies are sufficient to meet the demands of existing customers, there is not much room for expansion, McKenna said. About 83% of the company's gas comes from Gulf Coast fields through Algonquin Gas Transmission Co. and Tennessee Gas Pipeline Co., with the remainder being Algerian LNG



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imported by Distrigas of Massachusetts Corp., and from the company's own SNG and propane facilities.

"We feel we're too dependent upon peakshaving supplies," he said. "We want more basic pipeline supply. There is a large potential market for additional gas here."

McKenna said only about 30% of homes in Boston Gas' service area use gas for heating, and only 54% of the company's residential customers have gas furnaces or heaters. There are currently no hook-up restrictions.

Boston Gas is a member of the Boundary Gas consortium that is seeking to bring additional Canadian gas to the Northeast, and should be receiving the first gas from Boundary in late 1986. By then, McKenna said, the prospect is good that additional supplies also will be available from gas fields off Canada's East Coast.

"We have enough gas to grow on until then," he said. The tight supply has prevented the company from seeking new large customers, he said, which could bring down the price of gas for everyone.

"Our big competitor is oil," he said. "Right now we're about 87-90% the price of oil. We can compete with oil for the interruptible market but not the firm customer if additional capital investment is required. Oil's just too close to the price of natural gas."

The literal bottom line to any company is whether it makes a profit for its investors, and Boston Gas makes the grade in that category. In 1983, pre-tax earnings of \$37.4 million were up a whopping 84% from the \$20.3 million recorded in 1982. Most of the increase is attributed to new rates that were in effect for the full 12 months, but tightly controlled operating costs also played a major part. The current 15.5% allowable rate of return is based entirely on sales to firm customers, the 446,000 residential customers and the 33,000 commercial establishments using natural gas on a continuing basis.

A company also has to be a good citizen, and Boston Gas again makes the grade. Since 1981, the company has been helping low income customers receive fuel assistance from various government agencies. In 1983, Boston Gas processed payments totaling \$10.7 million for 26,000 customers under the program. A new program was developed in 1983 to help social service agencies obtain low interest loans for energy conservation projects.

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Brooklyn Union Copes With Urbanity

BROOKLYN UNION GAS CO.

First Year Of Operations: 1849
(Organized in 1825)

Service Area: The boroughs of Brooklyn, Staten Island, and two-thirds of Queens, all in New York City, an area of approximately 187 sq miles.

Number Of Meters: 1,075 million

Number Of Employees: 3,730

Pipeline Suppliers: Transcontinental Gas Pipe Line Corp.; Texas Eastern Transmission Corp.; and Tennessee Gas Pipeline Co.

1983 Gas Sales: 109 Bcf

1983 Operating Revenues: \$939 million

1983 Net Income: \$49 million

1983 Capital Expenditures: \$60 million

Across the Brooklyn Bridge from Manhattan Island is the borough of Brooklyn, the largest borough in the largest city in

the U.S. It is the home of Brooklyn Union Gas Co., a modern, aggressive utility operating in the most urban of urban environments.

Just look at the evidence. It has increased its heating customers from 267,200 in 1973 to 350,100 in 1983 while the population of the service area was dropping. It is a gas producer in places as far from New York City as West Virginia, through its Fuel Resources Inc. subsidiary, and as close as the Fresh Kills landfill, through its Methane Development Corp.

joint venture with Getty Synthetic Fuels. And unlike many urban gas utilities that have no opportunity for growth and new business inside its service area, Brooklyn Union serves growing suburban communities on Staten Island.

Brooklyn Union's direct ancestor, The Brooklyn Gas Light Co., was chartered in 1825. However, it refunded its stockholders' investment in 1834 before making any gas when it failed to receive a contract for street lighting. Thirteen years later, after Brooklyn had grown to



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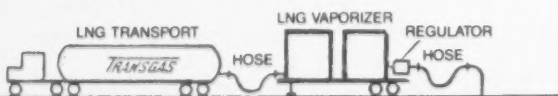
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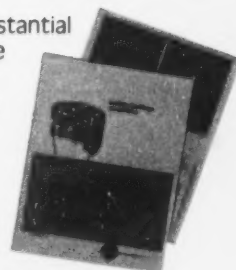


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Circle Card No. 117

Computerized mapping helps Brooklyn Union keep track of its facilities in rapidly growing Staten Island.

100,000 and become a chartered city, the gas company was revived. A contract for street lighting was obtained and a gas plant was built near the Brooklyn Navy Yard. The first gas was sent through 6½ miles of main late in 1849.

Brooklyn Union Gas was incorporated Sept. 9, 1895, consolidating many smaller gas companies then serving Queens and Brooklyn. The Staten Island service area came with the acquisition of Richmond Gas Co. in 1957.

A good portion of Brooklyn Union's system is more than 100 years old (although the average service is only 20 years old) and requires tender care, said Edward J. Anderson, director of engineering, distribution department.

"We have an aggressive program of preventive maintenance," he said. "We're inserting 1-in. plastic pipe into our bare steel service lines at the rate of about 10,000 to 11,000 per year and have already noticed a dramatic drop in our service calls."

Anderson said about 20,000 joints a year are sealed in the service area, using metallic and nonmetallic seals and an increasing number of internal joint seals.

"We use the internal joint seal system that allows a crew to seal 28 joints in a day with just two openings in the street," he said. "When they are through, you know that block is free of leaks."

"We feel that if we spend the money today we'll benefit through future savings. Our leak surveys exceed the state code requirements, which are noticeably more stringent than the federal code, hoping to find leaks before they get more severe," Anderson said. "We find about 5,000 leaks per year, and that's on a downward slope now. We've got to keep down the cost of gas to the consumer, and we've found we are able to do that through improved methods and innovative technology that is now coming onto the marketplace."

To ensure the longevity of its system, Brooklyn Union has exacting tests that all new material must meet before it can be installed and used.

"Nothing goes into the field unless and until it passes our tests first," said Anderson. "That covers valves, coatings, anodes — literally anything that is put into our system. We work very closely with many manufacturers so we can be sure items meet our specifications."

The rebuilding of New York City's infrastructure — its streets, its sewers, and its bridges — has been a small blessing and a

big headache for the gas company.

"The good thing is that we are able to replace and upgrade parts of our system, even eliminating double mains in some streets," Anderson said. "The bad thing is that our ratepayers wind up having to pay for work that is not required by the gas company, and which we can't get reimbursed for."

Anderson said utilities in New York City are in a unique position. When the company is forced to relocate gas lines due to street or sewer construction, the company pays all the expense. "We're there (in the street) at their pleasure," Anderson explained.

In 1983, capital expenditures associated with relocations due to government reconstruction work exceeded \$13 million, in addition to \$5 million in maintenance expenses to support and protect gas mains.

"Here in New York we're on the leading edge of the program to rebuild this nation's infrastructure," he said. "That expense is going to do nothing but get higher." The company is pushing for state and local legislation to allow utility reimbursements, Anderson said.

Brooklyn is also undergoing a private sector rebirth known as the "brownstone revolution," Anderson said some neighborhoods become more desirable than others, the shift in population overloads some mains as other mains become under-used. This results in the abandonment of some mains and upgrading of others.

Deciding when to abandon lines and where to upgrade lines used to be a difficult question, but Anderson said a network simulation system developed by Stoner Associates of Carlisle, Pa., has eliminated much of the guesswork involved in that decision.

"I'm an advocate of this approach," Anderson said. "It's saving us a tremendous amount of money. It can tell us in minutes if a main is needed when the temperature drops to 20 F, or if it isn't needed until it goes to 10 F. It is saving us many engineering hours."

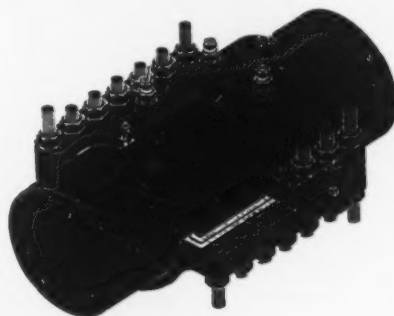
Brooklyn Union is aggressive in promoting gas cleanliness, dependability, and efficiency. New annualized firm load of 3.8 Bcf was added in 1983 despite higher gas costs, helping offset fixed costs through a broader customer base.

Conversions from oil heating totaled 5,100 in 1983, an important segment in the annual load increase. Most of the 1,600 new homes built in the service area



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Washington Gas Light:

Old Name, New Ideas

WASHINGTON GAS LIGHT CO.

First Year Of Operations: 1848

Service Area: The metropolitan Washington area, including the District of Columbia and adjacent areas of Maryland and Virginia, for a total of 624 sq miles. Wholly owned subsidiaries Shenandoah Gas Co. and Frederick Gas Co. provide gas service in the Shenandoah Valley area of Virginia and West Virginia and in Frederick County, Md.

Number Of Meters: 575,285

Number Of Employees: 3,388

Pipeline Suppliers: Columbia Gas Transmission Corp. and Transcontinental Gas Pipeline Corp.

1983 Gas Sales: 112 Bcf

1983 Operating Revenues: \$816 million

1983 Net Income: \$31 Million

1983 Capital Expenditures: \$33 million

in 1983 were equipped with gas furnaces, and 400 apartment buildings were converted to gas heat.

More than 85% of the company's gas comes from three pipelines under long term contracts: Transcontinental Gas Pipe Line Corp., Texas Eastern Transmission Corp., and Tennessee Gas Pipeline Co. In addition, the utility received 3 Bcf from its exploration subsidiary in 1983 and 1 Bcf from the Fresh Kills landfill.

Brooklyn Union also receives Algerian LNG imported by Distrigas of Massachusetts. The company has purchased its full contract volume of 13.6 Bcf per year from Distrigas for the past two years.

The company has a current maximum peak-day supply of approximately 969 MMcf to meet an estimated 0 F peak-day demand of 965 MMcf. Total includes LNG and SNG facilities at the Greenpoint Energy Center with capacities respectively of 229 MMcf and 60 MMcf.

The Washington Gas Light Co., the only gas utility in the U.S. created by an act of Congress, is a company with an old name but new ideas. Not only is gas lighting no longer part of its business in any noticeable sense, Washington itself is no longer the major part of its service area.

"The population of the District of Columbia is shrinking and the population of the surrounding Maryland and Virginia suburbs is growing," said Andrew Tarapchak, vice president of distribution. "We operate in a constantly growing area because of the federal government. This area grows at a moderate rate. We don't experience the economic slowdowns that big industrial cities experience."

Washington Gas was incorporated by Act of Congress July 8, 1848. The system was fairly small prior to World War II, but began growing rapidly after 1945.

"We have a fairly young system because before 1945 we experienced limited

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growth, but then it really boomed," said Patrick Clarke, general superintendent of distribution. "Now the District accounts for only about 27% of our therm sales. Maryland has about 43% of our sales, with the remainder in Northern Virginia."

To be successful in the 1980s, a gas utility must offer energy at a price that can compete with other sources. Washington Gas has used several methods to help keep gas competitive in its market place.

With the cost of gas such an important factor in the burner tip price, Washington Gas turned to some unconventional sources. The company was able to save \$7.5 million by purchasing gas directly from independent producers in 1983. Another \$5.9 million was saved by purchasing lower cost "excess gas" from one of its traditional pipeline suppliers. In total, 22% of Washington Gas' 1983 purchases was from such sources.

Computers also are helping cut costs at Washington Gas.

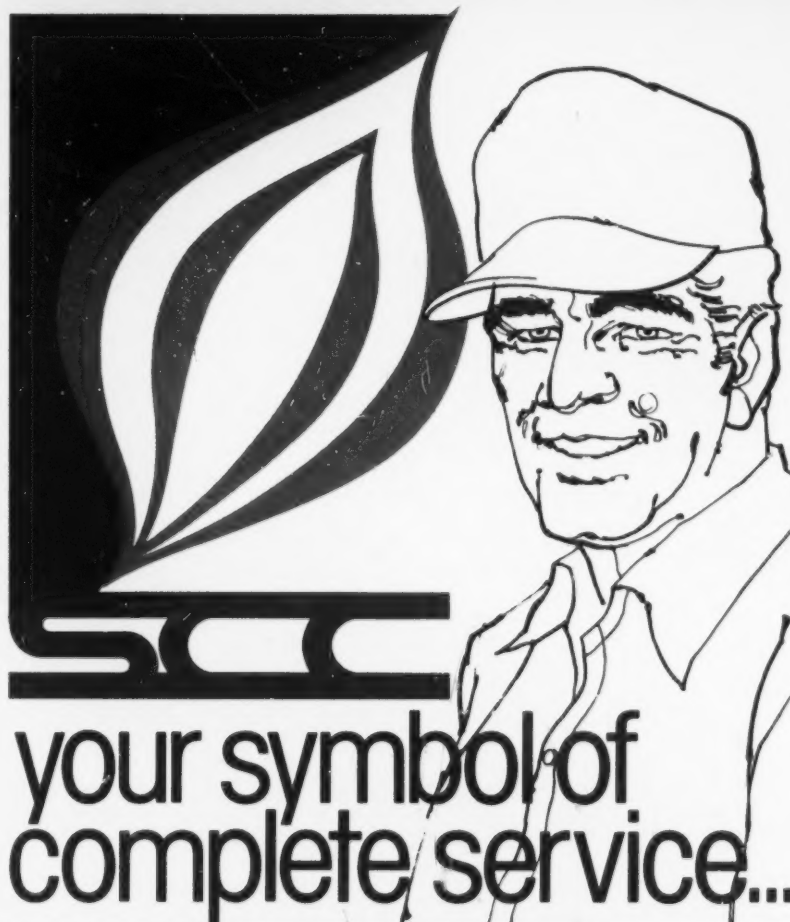
Two new programs were completed in 1983 after several years of work. A plant accounting system speeds up the reporting of property, plant, and equipment, and a jurisdictional accounting system has improved rate-case presentations by providing detailed, accurate data on cost of service in the three jurisdictions where the utility operates.

Two new information systems are to be on-line by late 1984. A new transportation management system will help in the operation, maintenance, and replacement of the vehicle fleet. A paving order system is designed to control paving costs and evaluate the performance of paving contractors.

Computers also are given much credit for reducing the company's operational expenses. E. W. "Ted" Lighton, director of gas control and system planning, said the network simulation computer system developed by Stoner Associates, Carlisle, Pa., helped the utility install 50% more services in 1983 than in 1982 at less than half the cost per service.

About 15% of the company's system is low pressure, practically all of that in the District, Clarke said. More than 200,000 of the existing service lines and 98% of all new services are plastic.

Washington Gas' 1983 construction program included the installation of 7,700 new services, an increase of more than 50% from 1982. The maintenance program in 1983 included renewal of 2,100 existing services and adding cathodic pro-



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Working near the National Shrine of the Immaculate Conception, Washington Gas Light crew repairs a main.



tection to another 423 miles of wrapped steel main.

Through most of the 1970s, Washington Gas was operating under a moratorium on new service connections. That has been off for several years, but the effects still are being felt.

"Like many other utilities, we have an electric blanket around some of the areas we serve," said Clarke. "During the 1970s, the homebuilders had to build all-electric homes in some areas because we were forbidden to hook up any new customers. Our biggest competitor here isn't fuel oil, it's the heat pump. We are very concerned about it. We're right on the border of the climate area where the heat pump is practical."

The company's goal is to expand within

a framework of the right mix of customer classes. Some customers are more profitable than others; large commercial and industrial customers provide more revenue and a better rate of return than do single family homes, for example.

The residential market is vital to Washington Gas because of the lack of heavy industrial facilities in the area. Even the concentration of large government office buildings in the District does not help. They are heated by two large central plants, only one of which burns gas, said Tarapchak. Washington Gas' largest customer is the University of Maryland at College Park, which it lost for a year to No. 6 oil before coming up with a rate schedule that brought UM back in 1983.

To increase its share of the residential market, Washington Gas tries to be responsive to builders' needs, Clarke said.

"Builders can sell either gas or electric

heating, but they prefer gas," he said. "We try to get into a development early. Home construction has changed completely in the last 10 years. It used to be that the streets were the last thing to go in, now they are the first."

In order to prevent the financial loss of having pipe in the ground months or years before customers are hooked up and revenues generated, Washington Gas keeps a close eye on construction schedules in a development and uses a construction method known as "sleeving."

While the development is still an open field, corrugated polyethylene pipe is installed below areas to be paved. Then, when the heavy machines have left, mains up to 6-in. and services are pulled through the pipe. Tarapchak said this prevents damage to installed facilities and cuts paving costs.

It's company policy to finance construction for new business through internally generated funds, without relying on bonds or loans. Company crews are used for maintenance and special projects, such as regulator stations, with contractors hired for major new construction projects.

"If we get caught short, then we'll use company crews for construction," said Clarke. "That helps us, since it gives us a cost comparison with contractor crews. We've been working with our contractors, trying to stabilize the workload so they aren't faced with laying crews off one month and trying to hire them back the next. So far, it's working."

A "one-cell" system known as "Miss Utility" is proving beneficial for Washington Gas. In 1983 alone, the system received 60,000 calls for digging in Washington Gas' service area.

"It's having a very noticeable effect," said Tarapchak. "Before it went into effect we would have 2,000 damages a year in a much smaller service area. Now it is down to about 800. If we have repeat offenders, we aren't reluctant to take them to court."

About half of the \$33.2 million in capital expenditures in 1983 was for new business. Another 24% went for replacing distribution facilities, and 6% was spent on gas exploration and development through its Crab Run Gas Co. and Hampshire Gas Co. subsidiaries. Capital expenditures for 1984 are set at \$45.5 million, almost half of which is earmarked for new business and 21% for replacement of distribution facilities.

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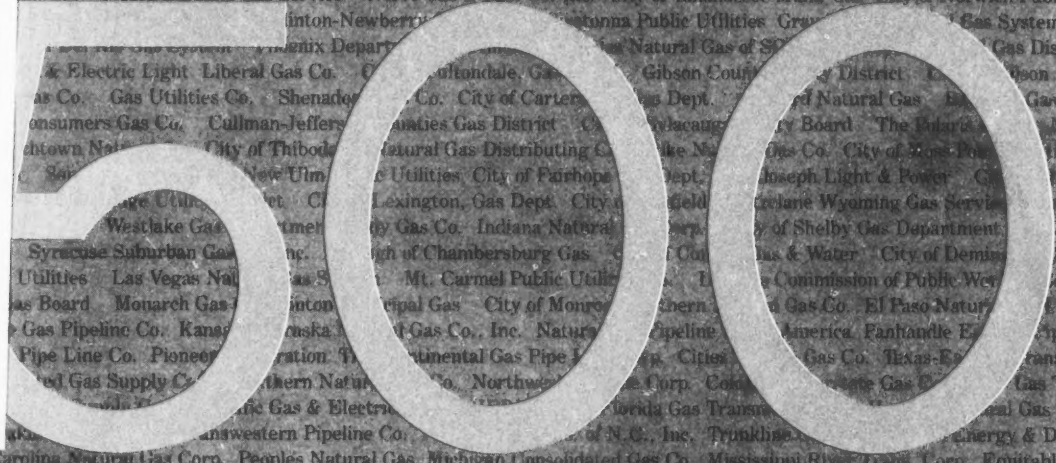
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PIPELINE & GAS JOURNAL

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The P&G



Details On The 500 Leading Companies Transporting Energy Through Pipelines

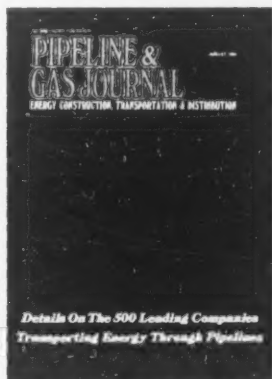
PIPELINE & GAS JOURNAL

Published continuously since 1859

August 1984 • Volume 211 • Number 10

International Pipeline & Gas Utility Design, Construction & Operation

P&GJ's Presentation Editor James Duke and Graphics Director Don Fickert see the P&GJ 500 Report as more than just a collection of data; it has graphic ramifications, too, and this issue's cover reflects their latest findings in the mass of information that even artists and art directors have to examine for ideas.



ON THE COVER:

P&GJ's 4th 500 Report conveys some interesting information about the pipeline energy business, which comprises 1,560 gas utilities, 500 gas gathering and transmission companies, and 500 liquids pipeline companies in the U.S. From this vast number, P&GJ has selected the top 300 gas utilities, 100 gas pipelines, and 100 liquids pipelines. These 500 represent 97% of all gas customers, 96% of all gas mains and services, 86% of all gas pipelines, and 61% of all oil pipelines.



IN THIS ISSUE

Bar code labels for gas meters, handheld microprocessors for reading gas meters; a fantastic material that makes wet backfill turn solid; nylon tubing for mains and services; devices to check for flaws in plastic pipe fusion joints; a roundup of internal pipe renovation methods — these are among the features of September's P&GJ report on Distribution Technology.



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Dual 20-in. crude and products line in west central India had to be uncovered by hand so pipe could be cleaned and recoated.

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Dimensions Of 500 Leading Energy Pipeline Companies THE 4th P&GJ 500

The companies surveyed in the 4th edition of PIPELINE & GAS JOURNAL's 500 Report supply energy to millions of Americans through one of the safest, most efficient transportation modes yet devised — the underground pipeline network.

This network stretches into every state of the union, collecting hydrocarbon energy at the wellhead and transporting it through various stages to the ultimate consumer. That consumer might be a steel mill or a suburban home or the local gasoline jobber — anything or anybody that requires energy.

There are approximately 1,560 gas utilities, 500 gas gathering and transmission

by **DENISE LUTTRALL**,

Editorial Assistant;

JIM WATTS,

Assistant Editor,

and **DEAN HALE**,

Editor

companies, and 500 liquids pipelines in the U.S. The 4th P&GJ 500 surveys and lists the vital statistics for almost 20% of all the energy pipeline companies in the U.S. These 500 companies account for 97% of the gas customers, 96% of the gas distribution mileage, 86% of the long distance gas transmission mileage, and

61% of the liquids (crude oil and refined products) mileage.

These companies hold billions of dollars worth of assets and spend billions in keeping their physical facilities in top operating condition. They are the giants, middle sized companies, and small companies. They are municipally owned, investor owned, and privately owned. They are varied, they are vital, and they provide the energy that we all need to live our modern lives.

The 300 leading gas utilities range from Southern California Gas Co. with its 3.9 million customers to Decatur Utilities with its 4,054 customers. Of the total gas

The 10 Biggest Spenders — Gas Transmission and Gathering Pipelines

Rank	Rank	Company Name	1983 Additions To Plant, \$(000)
83	84		
7	1	Texas Oil & Gas Corp.	480,330
-	2	United Gas Pipe Line Co.	331,827
1	3	Transcontinental Gas Pipe Line	147,330
9	4	Natural Gas Pipeline Co. of America	114,907
4	5	Tennessee Gas Pipeline Co.	114,648
-	6	Northwest Pipeline Corp.	97,000
-	7	United Texas Transmission Co.	66,490
5	8	Texas Eastern Gas Pipeline Co.	59,648
10	9	Southern Natural Gas Co.	47,383
-	10	ANR Pipeline Co.	44,828

(not including integrated companies)

The Top 10 In Revenues — Gas Transmission and Gathering Pipelines

Rank	Rank	Company Name	1983 Revenues \$(000)
83	84		
1	1	El Paso Natural Gas Co.	4,122,887
3	2	Columbia Gas Transmission Co.	3,860,155
2	3	Tennessee Gas Pipeline Co.	3,645,817
4	4	Transcontinental Gas Pipe Line	3,616,141
7	5	Texas Eastern Gas Pipeline Co.	3,146,927
8	6	Natural Gas Pipeline Co. of America	3,010,990
10	7	Northern Natural Gas Co.	2,673,229
6	8	United Gas Pipe Line Co.	2,645,257
-	9	ANR Pipeline Co.	2,636,800
-	10	Consolidated Gas Supply Corp.	2,374,965

The Top 10 Gas Transmission and Gathering Pipelines In MMcf Gas Sales

Rank	Rank	Company Name	1983 Sales MMcf
83	84		
8	1	Texas Eastern Gas Pipeline Co.	967,437
2	2	Natural Gas Pipeline Co. of America	921,206
5	3	El Paso Natural Gas Co.	876,000
1	4	Tennessee Gas Pipeline Co.	863,862
6	5	Transcontinental Gas Pipe Line	823,025
-	6	Columbia Gas Transmission Co.	771,043
-	7	Columbia Gulf Transmission Co.	675,091
-	8	Trunkline Gas Co.	605,716
10	9	Northern Natural Gas Co.	589,721
3	10	United Gas Pipe Line Co.	586,476

The 10 Biggest Spenders — Gas Distribution Utilities

Rank	Rank	Company Name	1983 Additions To Plant, \$(000)
83	84		
3	1	Public Service Electric & Gas Co.	77,013
5	2	Northern Illinois Gas Co.	64,248
7	3	Brooklyn Union Gas Co.	57,974
-	4	Montana-Dakota Utilities Co.	56,830
-	5	Atlanta Gas Light Co.	56,604
10	6	Peoples Gas Light & Coke Co., The	48,520
-	7	Entex Inc.	46,910
-	8	Michigan Consolidated Gas Co.	45,623
-	9	Public Service Co. of Colorado	43,427
-	10	Northern Indiana Public Service	43,224

(not including integrated companies)

The Top 10 In Revenues — Gas Distribution Utilities

Rank	Rank	Company Name	1983 Revenues \$(000)
83	84		
1	1	Southern California Gas Co.	4,499,508
3	2	Pacific Gas & Electric Co.	3,369,456
4	3	Columbia Gas Distribution Co.'s	2,862,849
8	4	Michigan Consolidated Gas Co.	1,952,466
7	5	Consolidated Gas Distribution Co.'s	1,935,563
6	6	Northern Illinois Gas Co.	1,921,766
5	7	Lone Star Gas Co.	1,840,131
-	8	Consumers Power Co.	1,399,896
2	9	Public Service Electric & Gas Co.	1,392,475
10	10	Peoples Gas Light & Coke Co., The	1,341,244

The Top 10 Gas Distribution Utilities In Miles of Mains

Rank	Rank	Company Name	Miles Of Mains
83	84		
1	1	Southern California Gas Co.	35,686
3	2	Pacific Gas & Electric Co.	30,346
2	3	Columbia Gas Distribution Co.'s	30,181
6	4	Consolidated Gas Distribution Co.'s	28,075
4	5	Northern Illinois Gas Co.	23,785
5	6	Entex Inc.	22,278
7	7	Lone Star Gas Co.	20,073
8	8	Consumers Power Co.	19,467
10	9	Atlanta Gas Light Co.	18,164
-	10	Arkla Inc.	15,579

distribution piping in the U.S., estimated at 1.4 million miles of mains and services, the top 300 utilities account for more than 1.3 million miles. The top 10 gas utilities alone serve more than 17.8 million customers and operate 227,000 miles of mains and 174,000 miles of service lines. Sales of the top 10 totaled 3.8 Tcf, down 13% from 4.3 Tcf in 1982.

The top 10 gas pipelines sold 6.3 Tcf in 1983 and had revenues totaling \$27.97 billion, compared to 1982 sales of 7.4 Tcf with identical revenues. The top 10 gas pipelines operated 148,915 miles of gathering and transmission lines as of Dec. 31, 1983, compared to 147,426 miles at

the end of 1982, an increase of 1,489 miles. Texas Eastern Gas Pipeline was first in gas sales in 1983, with 967 Bcf, compared to eighth in 1982 with sales of 885 Bcf. Texas Oil & Gas was first in additions to plant, with \$480 million in capital expenditures. El Paso Natural Gas was first in revenues among the gas pipelines for the fourth year in a row with revenues of \$4.122 billion.

The top 10 liquids pipeline companies delivered 4.8 billion bbl of crude and refined products out of their systems in 1983, compared to 4.7 billion bbl in 1982. The top 10 products pipelines delivered 2.3 billion bbl of refined products and the

top 10 crude oil lines carried 3.5 billion bbl.

The following tables provide an overview of the Top 10 companies in several categories; the complete tabular presentation gives a more complete overview of the 500 companies in the three categories.

PIPELINE & GAS JOURNAL assumes no responsibility for incomplete, non-current, or missing information for companies listed below who did not return the survey forms in a timely fashion, or for companies that might qualify but are not listed because they did not complete a survey form.

The 10 Biggest Spenders – Liquids Pipeline Companies

Rank		Company Name	1983 Additions To Plant, \$(000)
83	84		
8	1	Williams Pipe Line Co.	66,859
–	2	Texas Eastern Prod. Pipeline Co.	34,285
4	3	Loop Inc.	28,151
10	4	Exxon Pipeline Co.	24,182
7	5	Arco Pipe Line Co.	19,352
–	6	Amoco Pipeline Co.	16,264
–	7	American Petrofina Pipe Line	13,622
–	8	Gulf Pipeline Co.	12,796
–	9	Texas Pipe Line Co.	12,676
9	10	Sohio Pipe Line Co.	9,917

The Top 10 Liquids Pipelines – Revenues

Rank		Company Name	1983 Revenues \$(000)
83	84		
1	1	Sohio Pipe Line Co.	1,251,854
2	2	Arco Pipe Line Co.	895,332
3	3	Exxon Pipeline Co.	890,345
4	4	BP Pipeline Inc.	546,758
5	5	Colonial Pipeline Co.	475,395
6	6	Amoco Pipeline Co.	197,853
7	7	Lakehead Pipe Line Co.	188,713
8	8	Mobil Pipe Line Co.	155,184
9	9	Mobil Alaska Pipeline Co.	153,459
10	10	Shell Pipe Line Corp.	144,649

The Top 10 Liquids Pipeline Companies – In Mileage

Rank		Company Name	Total Miles Of Pipeline
83	84		
1	1	Amoco Pipeline Co.	12,272
2	2	Mobil Pipe Line Co.	11,150
3	3	Exxon Pipeline Co.	9,096
5	4	Williams Pipe Line Co.	8,447
6	5	Mid-America Pipeline Co.	8,233
4	6	Arco Pipe Line Co.	8,037
7	7	Continental Pipe Line Co.	7,370
8	8	Shell Pipe Line Corp.	7,076
9	9	Phillips Pipe Line Co.	5,615
10	10	Colonial Pipeline Co.	5,248

The Top 10 Products Pipeline Companies

Rank		Company Name	1983 Deliveries (000) Bbl Products
83	84		
1	1	Colonial Pipeline Co.	586,174
2	2	Buckeye Pipe Line Co.	253,837
3	3	Southern Pacific Pipe Line Co.	243,355
4	4	Gulf Pipeline Co.	197,257
–	5	Marathon Pipe Line Co.	194,983
5	6	Phillips Pipe Line Co.	181,091
6	7	Williams Pipe Line Co.	168,410
7	8	Plantation Pipe Line Co.	162,303
9	9	Arco Pipe Line Co.	152,398
–	10	Mid-America Pipeline Co.	138,414

The Top 10 Gas Distribution Utilities In MMcf Sales

Rank		Company Name	1983 Sales MMcf
83	84		
1	1	Southern California Gas Co.	796,127
2	2	Pacific Gas & Electric Co.	604,026
3	3	Columbia Gas Distribution Co.'s	467,229
5	4	Northern Illinois Gas Co.	411,607
6	5	Consolidated Gas Distribution Co.'s	391,976
4	6	Lone Star Gas Co.	380,652
7	7	Michigan Consolidated Gas Co.	359,091
10	8	Consumers Power Co.	273,243
8	9	Arkla Inc.	263,818
–	10	Oklahoma Natural Gas Div. (ONEOK)	251,301

The Top 10 Crude Pipelines

Rank		Company Name	1983 Deliveries (000) Bbl Crude
83	84		
1	1	Arco Pipe Line Co.	503,252
2	2	Exxon Pipeline Co.	457,016
3	3	Lakehead Pipe Line Co.	404,233
4	4	Shell Pipe Line Corp.	372,956
–	5	Marathon Pipe Line Co.	348,658
5	6	Amoco Pipeline Co.	322,830
6	7	Sohio Pipe Line Co.	303,501
9	8	Texas Pipe Line Co.	286,263
7	9	Gulf Pipeline Co.	253,956
8	10	Mobil Pipe Line Co.	199,998

The 300 Leading Gas Distribution Utilities

The P&GJ 500... dimensions of the pipeline energy business

Rank 83	Rank 84	Name Of Company	Number Of Customers	1983 Gas Sales, MMcf	1983 Oper. Revenues \$(000)	1983 Net Income \$(000)	Gas Plant Value \$(000) 12-31-83	Additions To Plant \$(000)	Miles Of Mains	Miles Of Services
1	1	Southern California Gas Co.	3,941,180	796,127	4,499,508	110,024	1,388,665	178,091	35,686	36,951
2	2	Pacific Gas & Electric Co.	2,948,943	604,026	3,369,456	198,274	2,041,806	67,731	30,346	23,797 ^B
3	3	Columbia Gas Distribution Co.'s	1,901,451	467,229	2,862,849	233,512	1,087,253	70,196	30,181	21,608
4	4	Consolidated Gas Distribution Co.'s	1,490,152	391,976	1,935,563	56,155	843,896	52,445	28,075	28,223
5	5	Northern Illinois Gas Co.	1,470,341	411,607	1,921,766	88,429	1,164,453	64,248	23,785	19,433
6	6	Public Service Electric & Gas Co.	1,330,411	201,504	1,392,475	389,779 ^A	695,718	77,013	12,752	12,587
7	7	Entex Inc. ^F	1,236,514	205,086	1,143,988	42,760	327,836	46,910	22,278	13,149
8	8	Lone Star Gas Co.	1,198,867	380,652	1,840,131	68,621	965,510	61,559	20,073	2,678
9	9	Consumers Power Co.	1,180,713	273,243	1,399,896	70,554	1,307,725	37,029	19,467	11,019 ^D
10	10	Brooklyn Union Gas Co. ^I	1,068,827	96,879	909,639	41,047	760,536	57,974	3,834	5,243
11	11	Michigan Consolidated Gas Co.	1,045,168	359,091	1,952,466	31,331	818,740	45,623	12,831	13,895
12	12	Consolidated Edison Co. of N.Y. Inc.	1,016,146	98,551	60,000	492,551 ^A	562,056	48,098	4,191	2,594
74	13	Kansas Power & Light Co., The	975,521	125,734	451,639	83,604 ^A	1,380,887 ^C	13,950	N A	N A
14	14	Atlanta Gas Light Co. ^F	874,264	220,102	1,113,714	18,020	628,406	56,604	18,164	15,420
13	15	Peoples Gas Light & Coke Co., The ^F	864,049	251,006	1,341,244	33,396	730,857	48,520	3,995	5,111
15	16	Gas Service Co., The ^H	853,385	178,209	873,137	11,419	418,540	18,085	13,109	5,783
17	17	Public Service Co. of Colorado	744,348	177,585	761,629	106,379 ^A	394,047	43,427	10,854	6,554
16	18	Arkla Inc.	718,567	263,818	1,036,412	59,123	1,117,978	60,113	15,579	7,477
18	19	National Fuel Gas Distr. Corp. ^I	673,302	156,422	1,011,291	30,193	692,232	58,267	12,914	11,437
19	20	Oklahoma Natural Gas Div. (ONEOK)	648,375	251,301	964,330	31,883	472,951	32,001	10,829	7,299

The 15 Largest Integrated Gas Utilities

Rank 83	Rank 84	Name of Company	No. of Customers	MMcf Sales	Miles of Mains	Miles of Trans. Lines	Additions To Plant \$(000), 1983
-	1	Pacific Lighting Corp.	3,941,182	793,917	35,687	3,301	249,956
1	2	Pacific Gas & Electric Co.	2,948,943	595,910	30,195	5,137	89,854
-	3	Columbia Gas System	1,901,537	876,299	30,181	24,000	138,492
-	4	Consolidated Natural Gas Co.	1,490,212	673,315	28,075	8,205	313,862
2	5	Lone Star Gas Co., Div. of Enserch	1,198,867	380,652	20,023	10,767	61,559
3	6	Consumers Power Co.	1,180,713	276,088	18,414	1,296	37,644
4	7	Michigan Consolidated Gas Co.	1,065,701	359,100	12,831	2,384	47,581
5	8	Arkla, Inc.	718,622	265,849	15,799	9,583	72,600
6	9	National Fuel Gas Co.	673,294	161,280	12,914	4,513	68,274
-	10	Southern Union Co.	658,000	123,297	12,808	2,527	32,864
7	11	Oklahoma Natural Gas Co. (ONEOK, Inc.)	648,332	278,074	10,829	4,624	37,408
8	12	Mountain Fuel Supply Co.	423,146	127,573	7,192	2,351	107,432
9	13	Southwest Gas Corp.	363,448	67,686	6,783	1,460	19,633
-	14	InterNorth, Inc. (Northern Natural; Peoples Nat. Gas. Divs.)	305,823	589,721	5,207	27,799	43,941
-	15	Equitable Gas Co.	259,701	69,699	3,372	5,114	21,864

A Includes electric
B Gross utility plant
C Total utility plant
D Formerly Haverhill Gas Co.
E Estimated
F Fiscal year ended 6-30-83
G FY ended 7-31-83
H FY ended 8-31-83
I FY ended 9-30-83
J FY ended 10-31-83
K FY ended 11-31-83
L FY ended 3-31-84
M For 9 months ended 9-30-83
N FY ended 6-30-83 for income, plant value, and additions only
O Acquired by Kansas Power & Light, 10-83
P Includes Manchester Gas and Gas Service of N.H.
Q Owns part of the Trans-Alaska Oil Pipeline
R Now includes Amdel Pipeline and Cosden Pipe Line

The Top 10 Combination Gas & Electric Utilities — By Gas Customers

Rank 83	Rank 84	Company Name	No. of Customers	1983 MMcf Sales	Miles of Mains
1	1	Pacific Gas & Electric Co.	2,948,943	604,026	30,346
2	2	Public Service Electric & Gas Co.	1,330,411	201,504	12,752
3	3	Consumers Power Co.	1,180,713	273,243	19,467
4	4	Consolidated Edison Co. of N.Y.	1,016,146	98,551	4,191
5	5	Public Service Co. of Colo.	744,348	177,585	10,854
6	6	Northern Indiana Public Serv. Co.	532,406	233,425	9,436
7	7	San Diego Gas & Electric Co.	530,256	42,859	5,204
8	8	Baltimore Gas & Electric Co.	513,970	86,186	4,257
9	9	Niagara Mohawk Power Co.	430,820	103,153	5,968
10	10	Long Island Lighting Co.	400,443	47,566	5,900

The P&GJ 500...dimensions of the pipeline energy business

Rank 83	Rank 84	Name Of Company	Number Of Customers	1983 Gas Sales MMcf	1983 Oper. Revenues \$(000)	1983 Net Income \$(000)	Gas Plant Value \$(000) 12-31-83	Additions To Plant \$(000)	Miles Of Main	Miles Of Services
21	21	Washington Gas Light Co.	575,285	114,125	815,666	30,575	495,421	33,151	6,767	8,033
20	22	Minnegasco Inc.	572,440	138,845	742,588	23,245	239,658	18,493	8,185	5,503
22	23	Laclede Gas Co. ¹	539,267	102,740	650,803	17,200	248,626	16,895	6,124	5,804
24	24	Northern Indiana Public Service	532,406	233,425	1,021,781	137,849 ^A	691,674 ^B	43,224	9,436	10,039
25	25	San Diego Gas & Electric Co.	530,256	42,859	323,100	22,296	176,832	17,553	5,204	4,199
23	26	Philadelphia Gas Works ^H	518,000	72,537	502,305	23,857	407,358	29,180	2,989	5,016
26	27	Baltimore Gas & Electric Co.	513,970	86,186	545,295	216,453	332,059	20,467	4,257	4,324
27	28	Boston Gas Co.	480,098	83,810	568,161	20,244	230,733	11,698	5,665	4,188
28	29	Niagara Mohawk Power Corp.	430,820	103,153	608,587	312,409 ^A	429,133	37,444	5,968	4,027
29	30	Mountain Fuel Supply Co.	423,146	111,233	567,007	55,683	714,466	107,432	7,192	5,024
30	31	Wisconsin Gas Co.	411,070	112,836	635,344	17,274	214,689	17,197	6,014	4,658
31	32	Long Island Lighting Co.	400,443	47,566	349,726	28,950	360,174	19,037	5,900	4,261
32	33	Illinois Power Co.	382,476	86,667	1,278,259 ^A	210,800 ^A	366,651	15,251	7,238	5,073
34	34	Southwest Gas Corp.	363,451	64,014	384,860	16,651	256,639	20,133	6,784	3,924
33	35	Southern Union Gas Co.	362,000	53,000	208,461	8,040	138,500 ^F	15,260	6,411	2,814
35	36	Alabama Gas Corp. ¹	353,945	75,338	391,435	6,235	116,548	8,903	6,142	7,004
36	37	Arizona Public Service Co.	337,665	36,339	202,134	264,797	4,033,400 ^C	N A	6,180	3,904
37	38	Indiana Gas Co. Inc.	304,799	73,381	416,072	14,193	241,180	21,239	6,639	4,814
39	39	Peoples Natural Gas Div., InterNorth	303,594	123,359	553,934	9,558	135,762	12,642	5,208	3,308
40	40	Philadelphia Electric Co.	301,754	64,864	417,042	26,725	332,074	21,297	4,493	3,128
38	41	Cincinnati Gas & Electric Co., The	301,517	70,080	421,984	145,876 ^A	133,931	10,337	3,478	805
42	42	Gas Co. of New Mexico	298,320	67,125	343,238	8,248	200,911	13,035	6,364	1,518
41	43	Northern States Power Co.	292,300	71,850	399,754	N A	279,088	10,775	4,481	3,134
43	44	Energas (Pioneer Corp.) ^J	286,329	82,726	302,259	4,097	45,100	5,057	10,753	624
44	45	San Antonio City Public Service	274,739	26,653	140,049	2,525	158,979	6,296	3,485	3,023
45	46	Dayton Power & Light Co.	263,766	48,257	288,780	N A	127,376	4,456	3,899	741
46	47	Equitable Gas Co.	259,701	69,699	362,200	15,300	217,778	25,953	3,372	2,453 ^F
47	48	Washington Natural Gas Co. ¹	253,803	51,696	334,629	8,933	242,052	23,791	6,085	6,151
48	49	Northwest Natural Gas Co.	249,851	59,685	360,574	17,207	307,265	24,721	7,669	4,718
49	50	New Jersey Natural Gas Co. ¹	244,474	49,271	279,117	8,105	154,979	18,602	4,058	3,933
52	51	Memphis Light, Gas & Water	234,539	57,860	267,766	14,236	94,435	5,559	926	2,321
53	52	Rochester Gas & Electric Corp.	233,284	42,881	756,061 ^A	86,248 ^A	212,521	9,981	3,580	2,829
51	53	Louisville Gas & Electric Co.	233,088	48,276	230,597	59,698	91,771	4,819	850	2,854
50	54	Louisiana Gas Service Co. ¹	232,312	19,798	141,459	1,805	73,863	8,763	3,751	2,316
54	55	Iowa-Illinois Gas & Electric Co.	224,939	62,795	281,800	59,522	109,759	3,984	3,655	2,610
55	56	Bay State Gas Co.	223,709	43,231	307,223	6,976	188,402	13,268	2,310 ^F	2,083
62	57	K N Energy Inc.	223,487	112,227	465,706	22,828	506,465	27,971	3,746	2,789
56	58	Wisconsin Natural Gas Co.	221,199	62,019	341,434	10,969	157,880	16,817	4,277	2,875
59	59	Mississippi Valley Gas Co.	219,180	49,168	232,110	4,864	51,747	4,734	3,852	3,126
57	60	Citizens Gas & Coke Utility	214,405	45,556	268,779	11,406	233,794	10,543	2,989	3,667
60	61	Piedmont Natural Gas Co. ^d	206,605	60,030	346,503	11,868	173,117	15,830	5,422	1,898
58	62	UGI Corp.	206,060	55,820	376,741	27,467	215,852	13,194	3,268	1,987
61	63	Commonwealth Gas Co.	201,619	39,286	261,206	10,929	106,320	7,552	2,377	1,598
63	64	Elizabethtown Gas Co.	197,316	43,523	272,403	11,692	113,716	10,694	2,160	4,692
64	65	South Carolina Electric & Gas Co.	187,638	65,892	337,282	103,938 ^A	137,647	14,410	5,793	4,637
65	66	Central Illinois Light Co.	183,234	39,564	525,857 ^A	44,679 ^A	211,008	9,429	3,210	2,797
67	67	Montana-Dakota Utilities Co.	177,246	45,307	218,956	35,997	207,564	56,830	3,293	2,612
66	68	New Orleans Public Service Inc.	173,045	22,453	136,352	-1,764	47,525	2,872	1,473	3,591 ^E
68	69	Peoples Gas System Inc., Tampa	169,376	41,881	189,711	6,070	151,740	9,465	4,251	2,664
69	70	Public Service of N.C. Inc.	160,059	43,808	247,317	8,254	140,051	15,237	3,649	1,500

ON THE FAST TRACK...

Diversified Energies Inc.: Outlook Is Bright

"Minnegasco Cares" is the theme of all communication and customer contact programs of the major company in Diversified Energies Inc.'s five-company empire. Minnegasco Inc. does care, and the results are impressive. Minnegasco again has received an "AA" rating from Standard & Poors Corp. and Moody's Investors Service — one of only three gas distribution companies in the U.S. with such a rating.

Minnegasco, serving 573,000 customers in 224 communities in three states, accounts for about 96% of DEI's total revenues. Sales to industrial and commercial customers represent about 48% of the company's total 1983 gas sales. Thanks to substantial improvement in non-regulated appliance sales and repair service businesses, Minnegasco's net income was up 9%, even though gas sales were down.

Minnegasco intends to keep moving ahead. A 15-year strategic plan is now in effect, providing a foundation for annual tactical planning to advance the utility toward its stated mission, objectives, and strategies. Credit for the plan lies with Albert D. Etchelecu, president and CEO,

who also is president and CEO of Diversified Energies Inc.

DEI's other businesses include oil and gas development drilling, oilfield services, energy management, and land development through four wholly-owned companies.

DEI Oil & Gas, Inc. is involved in a 50-50 joint venture (\$36 million in 1984) with Cenergy Exploration Co. of Dallas. It has interests in 43 wells, with 19 of them producers, six being completed, seven being drilled, and 11 plugged and abandoned. Most recently, DEI Oil & Gas entered a 50-50 joint venture (\$20 to \$25 million in 1984) with Petrus (H. Ross Perot's firm) to drill for and produce oil and gas.

Major oilfield services are provided by Cal Dive, a diving and subseas services firm to the oil and gas industry with offices in Texas, Louisiana, and California and operations worldwide.

Minneapolis Energy Center Inc., manages downtown Minneapolis district heating and cooling systems, providing steam for heating and chilled water for cooling by pipeline to some 60 commercial customers.

The Preserve, 15 miles from downtown, has only 100 acres (of 1,200) left to sell in a planned environmental concept. The project began in 1972.

Albert D. Etchelecu, left, president and chief executive officer, and Paul W. Kraemer, chairman of the board, Diversified Energies, Inc.

The P&GJ 500... dimensions of the pipeline energy business

Rank 83	Rank 84	Name Of Company	Number Of Customers	1983 Gas Sales, MMcf	1983 Oper. Revenues (\$000)	1983 Net Income (\$000)	Gas Plant Value (\$000) 12-31-83	Additions To Plant (\$000)	Miles Of Mains	Miles Of Services
76	71	South Jersey Gas Co.	157,712	37,840	240,833	8,112	168,041	13,680	3,393	2,358
72	72	Central Illinois Public Service Co.	155,248	33,899	180,066	85,466 ^A	131,826 ^B	5,000	1,327	2,597
71	73	Northeast Utilities	154,808	27,661	238,999	11,643	240,811	19,553	2,337	1,160
70	74	Wisconsin Public Service Corp.	154,755	45,345	629,891	51,594	117,309	6,203	2,785	2,076
73	75	Western Kentucky Gas Co.	139,024	36,281	166,646	2,613	49,387	4,035	2,872	887
77	76	Southern Connecticut Gas Co., The	136,115	20,157	163,655	7,382	111,401	8,208	1,800	1,296 ^C
75	77	Iowa Gas Co.	133,500	31,887	170,902	4,774	64,779	3,937	2,025	2,057
78	78	Iowa Electric Light & Power Co.	132,587	34,112	444,713 ^A	27,898 ^A	67,173	3,145	2,140	1,988
80	79	Metropolitan Util. District, Omaha	131,866	31,764	155,704	2,571	69,671	3,238	1,713	1,974
79	80	New York State Electric & Gas Corp.	130,353	33,524	207,866	156,680 ^A	97,299	5,103	3,877	1,462
86	81	United Cities Gas Co.	128,032	24,461	127,985	1,948	86,101	5,753	2,387	2,066
81	82	Long Beach Gas Dept.	126,780	29,353	146,049	16,847	54,504	2,122	896	1,654
82	83	Connecticut Natural Gas Co.	126,128	24,606	183,010	6,756	139,609	11,154	1,595	1,394
84	84	Iowa Public Service Co.	124,761	35,216	388,090 ^A	39,296 ^A	77,800	2,670	1,897	1,705
83	85	Virginia Natural Gas Div. (VEPCO)	122,237	19,013	123,933	N A	65,180	6,238	2,151	2,315
85	86	Providence Gas Co. ¹	122,155	20,528	155,607	3,930	68,326	6,396	1,714	1,211
87	87	Pennsylvania Gas & Water Co.	113,223	32,014	194,230	10,203	142,935	5,565	1,939	708 ^E
88	88	Michigan Energy Resources Co.	106,330	31,496	165,884	3,937	118,731	5,601	2,585	2,361
89	89	Wisconsin Power & Light	104,838	25,241	145,663	54,587 ^A	104,461	5,592	2,140	1,204 ^E
90	90	Montana Power Co.	102,490	31,439	145,702	11,190	276,797	5,998	1,826	1,967

The P&GJ 500... dimensions of the pipeline energy business

Rank 83	84	Name Of Company	Number Of Customers	1983 Gas Sales, MMcf	1983 Oper. Revenues (\$'000)	1983 Net Income (\$'000)	Gas Plant Value (\$'000) 12-31-83	Additions To Plant (\$'000)	Miles Of Main	Miles Of Services
91	91	North Shore Gas Co.	97,756	33,512	154,784	6,412	110,762	245	1,660	1,520
93	92	Intermountain Gas Co. ¹	94,909	23,714	139,877	5,130	72,092	3,189	3,100	1,828
92	93	City Gas of Florida ¹	94,575	7,200	40,154	1,815	45,851	1,526	3,047	1,077
96	94	Colorado Springs DPU	93,817	18,339	94,406	1,405	33,195	6,052	1,354	496
94	95	Colonial Gas Co.	92,631	14,349	119,329	5,291	88,603	7,073	2,021	1,235
95	96	Orange & Rockland Utilities	91,490	22,538	526,045 ^A	36,102 ^A	71,825	458	1,477	1,257
97	97	Mobile Gas Service Co. ¹	87,427	128,732	78,783	1,792	34,416	2,599	1,265	1,623
99	98	North Carolina Natural Gas ¹	86,000	24,570	166,472	3,263	58,965	4,625	1,901	854
98	99	Gulf States Utilities Co.	85,190	9,513	47,102	-271	17,929	713	1,343	1,180
100	100	Cascade Natural Gas Corp.	83,643	34,268	184,842	2,403	109,569	10,459	2,857	1,407
101	101	Washington Water Power Co.	75,420	22,730	120,580	9,460	59,139	1,614	2,194	1,293
102	102	Delmarva Power & Light Co.	74,512	16,450	93,680	4,887	70,454	4,735	1,028	875
103	103	Arkansas Western Gas Co.	74,287	15,800	68,499	4,119	36,110	6,397	1,902	307
104	104	Richmond (Va.) City of ^F	71,090	12,916	83,363	1,517	40,377	4,784	1,005	1,100
105	105	Michigan Power Co.	70,466	20,611	105,024	1,269	46,497	1,609	1,547	1,122 ^E
106	106	Madison Gas & Electric Co.	70,162	15,434	214,103 ^A	18,805 ^A	66,736	4,224	1,263	988
108	107	TransLouisiana Gas Co. Inc.	69,969	7,761	50,385	2,605	42,357	5,478	1,840 ^E	678 ^E
110	108	Southeastern Michigan Gas Co.	67,073	13,685	81,474	3,153	55,680	2,570	1,330	755
114	109	Gasco Inc.	66,711	4,814	71,723	3,449	52,020	2,265	590	533
112	110	Greeley Gas Co.	66,225	13,766	63,792	N A	N A	N A	1,481	753
107	111	Nashville Gas Co. ^M	66,212	17,790	91,295	1,340	38,669	2,613	1,716	N A
111	112	Associated Natural Gas Co.	65,710	10,960	57,255	1,580	21,676	1,250	1,336	621
113	113	Northwestern Public Service Co.	64,751	13,364	58,332	9,463	29,942 ^B	737	1,076	1,072
109	114	Rio Grande Valley Gas Co.	64,261	5,778	37,831	1,828	37,450	5,750	1,754	226
116	115	North Central Public Service Co.	64,037	15,228	76,489	5,023 ^A	23,155	2,449	1,363	727
115	116	Southern Indiana Gas & Elect. Co.	63,858	18,144	276,727	27,105	23,164	2,563	1,107	731 ^E
117	117	Union Light, Heat & Power Co., The	60,554	11,294	70,899	5,030	37,096	3,175	729	153
146	118	Penn Fuel System, Inc.	60,326	32,734	161,816	3,236	70,682	3,007	2,477	969
118	119	Corpus Christi Gas Division	57,401	4,867	29,632	581	21,000	3,628	1,013	12
120	120	Sierra Pacific Power Co.	55,208	7,016	50,014	3,851	344,944	2,252	625	450
122	121	Springfield City Utilities	54,724	10,481	52,301	3,057	33,921	2,381	783	877
119	122	Union Gas System Inc.	54,396	12,604	45,603	609	11,255	1,036	2,810	572
121	123	Arkansas Oklahoma Corp.	53,957	12,084	31,470	1,332	36,821	4,047	589	403
123	124	CP National Corp.	53,646	7,565	53,439	2,747	33,975	2,973	1,346	N A
125	125	Enstar (Anchorage Natural Gas)	52,000	36,041	N A	N A	N A	N A	544	495
124	126	Missouri Utilities Co.	48,555	4,341	33,891	3,252	24,872	2,161	848	552
125	127	Central Hudson Gas & Elect. Corp.	47,187	9,837	61,649	35,329	58,322	3,228	708	456
126	128	Valley Resources Inc. ^H	46,795	6,207	47,831	1,451	21,251	572	489	336
127	129	Interstate Power Co.	45,023	25,808	97,241	-933	31,307	4,539	840	N A
128	130	Energy Services of Pensacola	43,660	4,192	29,550	4,997	14,068	N A	944	619
129	131	Florida Public Utilities Co.	41,419	6,759	31,767	1,592 ^A	16,184	1,774	604	N A
130	132	Fall River Gas Co.	41,337	5,829	40,725	1,573	15,669	854	443	347
131	133	Missouri Public Service Co.	39,799	7,781	44,205	23,604	29,832	1,761	864	497
133	134	Wisconsin Fuel & Light Co.	37,886	13,935	69,463	1,427	12,962	1,366	853	554
134	135	Wisconsin Southern Gas Co. Inc.	37,869	8,030	39,983	1,066	15,663	1,450	1,002	612
132	136	Iowa Southern Utilities Co.	37,763	8,243	43,638	206	13,618	630	662	558
175	137	EnergyNorth Inc. ^P	35,435	5,937	42,568	820	26,503	3,263	604	401
135	138	Missouri Power & Light	34,963	6,995	32,232	1,181	26,454	1,277	708	450
136	139	Terre Haute Gas Co.	33,172	15,293	60,226	N A	N A	N A	704	N A
137	140	Roanoke Gas Co. ¹	32,072	7,202	45,851	1,304	15,372	86	413	300

Cable TV and gas distribution have more in common than might be imagined. At Piedmont Natural Gas Co., they found that the expertise developed in underground gas main and service construction, along with the equipment and crews, can be used successfully in a cable television service distribution operation. So can skills in accounting, billing, collection, and marketing.

The Charlotte, N.C. gas utility added its cable TV operation in 1982 because the gas business had leveled off and the company had a surplus of crews, equipment, and ability. The plan worked. It was so successful that in 1983 Piedmont's new subsidiary expanded into cable TV and telephone cable design and construction. The PNG Communications Division also is involved in a joint venture firm that builds both aerial and underground cable systems. Recently it bid on a New England cable TV system and got the job.

Cable TV is only one of the many ways that Piedmont, under leadership of John Maxheim, president and CEO, has expanded its vistas. Recognizing that the firm had to get outside the slow-moving gas utility field, Maxheim turned company attention to non-utility activities that are energy related. These include sale of LP-gas and associated products, especially

ON THE FAST TRACK...

Piedmont Natural Gas: Profitable Alternatives

propane carburetion for vehicle fleets; residential and commercial gas appliances; solar energy systems; energy conservation products and services; and commercial coal and fuel oil. Most activities now are separate divisions.

Piedmont Natural simultaneously is aggressively selling and leasing appliances; working with *Popular Science* magazine in evaluating new gas furnaces and equipment for homes; adding new customers via comprehensive marketing programs; and, through PNG Energy Co., is acting as agent for several of its large industrial customers for purchase and transportation of gas at prices competitive with alternate fuels.

Piedmont now is ranked by *Financial World* as one of its top 13 blue chip stocks (only utility on the list). Moody's and Standard & Poor's both have raised the utility into the "A" range. Piedmont's fast track approach to "making hay" even when the sun isn't shining illustrates that alternatives can be profitable, and, if they are profitable, they can be fun.



Wate F. Schiefer, vice president - gas supply and transportation, and William L. Lindner, vice president - technology, check plans for Piedmont's innovative gas transportation program.

The P&GJ 500... dimensions of the pipeline energy business

Rank 83	Rank 84	Name Of Company	Number Of Customers	1983 Gas Sales, MMcf	1983 Oper Revenues \$(000)	1983 Net Income \$(000)	Gas Plant Value \$(000) 12-31-83	Additions To Plant \$(000)	Miles Of Main	Miles Of Services
138	141	Battle Creek Gas Co. ⁱ	31,284	10,133	53,095	1,816	33,496	1,571	518	360
139	142	SE Alabama Gas District	30,702	7,390	35,266	445	26,037	153	778	470
142	143	Essex County Gas Co. ^h	29,941	4,314	34,807	1,386	30,393	3,074	563	387
141	144	Chattanooga Gas Co.	28,599	14,583	76,157	1,547	40,103	1,497	826	404
144	145	Delta Natural Gas Co. ^j	28,574	4,930	27,493	1,011	20,134	2,540	792	263
143	146	Kokomo Gas & Fuel Co.	28,281	10,551	41,364	N A	N A	N A	544	444
147	147	Huntsville Util. Gas System	26,109	5,574	22,103	N A	N A	N A	535	399
145	148	Berkshire Gas Co. ^f	25,827	5,076	36,694	1,078	25,997	2,939	573	320
148	149	Ohio Gas Co.	25,166	6,705	31,322	1,862	27,627	2,212	504	410
149	150	Alexandria Gas Dept.	24,250	3,078	7,242	N A	N A	N A	57	229
151	151	Cheyenne Light Fuel & Power Co.	23,944	7,268	29,661	N A	8,245	782	418	N A
150	152	Ohio Valley Gas	23,898	6,837	28,369	N A	N A	N A	563	240
	153	Hoosier Gas Corp.	23,198	4,094	19,791	N A	N A	N A	406	750
153	154	Hamilton, City of	22,960	4,669	20,011	N A	N A	N A	211	219
152	155	Palo Alto, City of	22,932	3,412	16,506	234	3,939	304	205	215
156	156	Rocky Mountain Natural Gas	22,406	4,722	23,144	284	27,715	1,943	464	418
155	157	Great Falls Gas Co. ^f	22,094	4,536	22,110	574	8,056	326	354	420
158	158	Austell Natural Gas System	22,092	2,830	15,420	N A	15,670	540	497	443
154	159	Mesa, City of ⁿ	21,998	2,415	15,196	1,413	12,663	612	541	279
157	160	Duluth Dept. of Water & Gas, City of	21,069	4,443	24,816	875	24,284	1,746	419	250

ON THE FAST TRACK...

Transcontinental Gas Pipe Line: Opportunities In Transition

Some companies resist change, fearing the unknown dangers lying in wait for the unwary and the unconventional. Others see opportunities rather than risks, and welcome changes. A member of the latter category, Transcontinental Gas Pipeline Corp., through its industrial marketing and contract carriage programs, has become a trailblazer during a period of transition in the natural gas business.

Increased competition from fuel oil in the industrial marketplace was experienced across much of the U.S. in 1983. Nowhere was this more obvious than in Transco's market area, from south of Atlanta to north of New York City. Competition also came from other pipelines in the area.

To counteract declining gas sales, Transco implemented the Industrial Sales Program in May. Under this program, the first special marketing program approved by FERC, Transco acts as agents for its



W.J. "Jack" Bowen, left, chairman and CEO of Transco, and Brian E. O'Neill, right, president of Transcontinental Gas Pipe Line.

utility customers. The pipeline calculates a monthly spot market price for gas that is competitive with certain alternate fuels, and transports the gas to the city gate from the wellhead. The Contract Carriage Program was implemented in July to retain markets that the pipeline cannot serve under the ISP or other tariffs. In this program, Transco identifies specific gas supplies for direct purchase by its customers and then transports the gas to meet a particular local market demand.

The company transported approximately 59 Bcf under the two programs in 1983.

Transco has been able to keep down

prices with two programs initiated November 1. Under the Market Retention Program, the company offered to purchase approximately 400 MMcf/d at a posted price of \$3.10/MMBtu or less. This program provides the company's producers a chance to increase their sales above a production cutback level already established by Transco.

Also in November, Transco cut the price it was willing to pay for NGPA sections 102, 103, 107, and 108 gas to \$2.80/MMBtu. An incentive price of \$3.40/MMBtu is being offered to producers that waive certain take-or-pay claims.

The company spent \$147.3 million on pipeline capital expenditures in 1983 and expects to spend \$223 million on capital expenditures in 1984.

The P&GJ 500...dimensions of the pipeline energy business

Rank 83	Rank 84	Name Of Company	Number Of Customers	1983 Gas Sales, MMcf	1983 Oper. Revenues \$(000)	1983 Net Income \$(000)	Gas Plant Value \$(000) 12-31-83	Additions To Plant \$(000)	Miles Of Mains	Miles Of Services
159	161	Willmut Gas & Oil	20,296	3,274	16,013	N A	N A	N A	500	191
164	162	Knoxville Utilities Board	20,232	6,474	34,568	N A	N A	N A	672	405
162	163	Inter-City Gas Corp. Inc.	20,095	10,916	51,911	N A	N A	N A	417	333
160	164	Brazos River Gas Co.	20,056	2,880	12,854	150	4,377	366	521	37
161	165	Albany Water Gas & Light Comm ^F	20,000	4,400	19,000	2,000	18,000	100	335	600
168	166	Gulf Natural Gas Co.	19,145	3,500	N A	N A	N A	N A	465	182
165	167	Okaloosa County Gas District	18,879	2,367	15,220	500	12,981	N A	585	515
166	168	Northern Indiana Fuel & Light Co. Inc.	18,494	4,532	26,520	822	11,991	1,124	492	210
167	169	South Coast Gas Co. ^F	18,033	1,506	8,864	2,862	7,218	216	495	248
169	170	Kansas Public Service Co.	17,766	3,450	10,967	N A	N A	N A	258	174
171	171	Union Electric Co.	17,162	16,608	104,898	2,995	77,473	4,426	2,392	N A
170	172	Great River Co.	17,147	5,502	30,106	-78	9,849	384	444	167
172	173	Jackson Utility Division	16,247	5,313	25,290	518	9,032	697	391	288
173	174	National Gas & Oil Corp.	16,109	13,897	58,472	3,169	27,673	2,132	1,037	113
174	175	Citizens Utilities	15,880	2,514	15,452	N A	505,086 ^C	4,048	326	28
183	176	Gainesville Gas Co.	15,235	2,989	N A	N A	N A	N A	320	139 ^E
176	177	Northern Gas Co.	15,045	3,125	10,660	N A	N A	N A	274	142
177	178	Fitchburg Gas & Electric Light	15,023	2,179	48,877	3,288 ^A	12,330	734	294	170
179	179	Danville Gas Dept., City of ^F	14,950	5,005	22,928	1,042	5,355	414	248	178
178	180	Trussville Utilities Board	14,843	10,120	N A	10,169	19,864	N A	310	371

ON THE FAST TRACK...

Memphis Light, Gas and Water: Innovations, Marketing Pay Off

Memphis declares that the city no longer is "the best kept secret in America." It is also no secret that Memphis Light, Gas and Water Division is an active partner in promoting the city as a major distribution center (sixth in the U.S.).

An innovative and assertive organization, MLGW utilizes technical improvements, energy source innovations, and strong commercial and industrial marketing programs to add emphasis to its reliable gas service.

Marketing, under Ira Stanfill, vice president of marketing and energy systems, is concentrating on re-establishing liaison with its 120 largest commercial and industrial users (the million-dollar accounts), many of whom were found to be planning expansion but not planning to use gas because they were uncertain of its future. Marketing personnel now have weekly breakfast meetings, inviting one or two people from three or four companies, to discuss and solve problems, talk about the future, conduct question and answer sessions, and improve relationships.



New and innovative approaches to gas marketing are discussed by Memphis Light, Gas and Water's Ira C. Stanfill, left, vice president, marketing and energy systems; Paul Harris, manager, commercial and industrial marketing; and Larry Papasan, president of MLGW.

Seminars for fleet users of compressed natural gas (as a vehicle fuel) have been exceptionally successful.

Newest marketing project is involvement in special programs whereby MLGW will act as a broker for industrial customers and arrange purchase and transportation for those customers.

A unique "pressure reduction system" — utilizing turbines powered by the pressure drop available in gas at city gate stations where pressure is reduced from pipeline to street main pressures — is now

operating. The turbine powers a generator that delivers 3 million kwh annually to the electric distribution system. Recovery of landfill gas is another energy project under development.

Most unique project is ownership and operation of a 14-mile crude oil pipeline from nearby Capline to a refinery owned by MAPCO, on the Mississippi River, and an 8-mile products line from the refinery to the Memphis airport. The lines transport crude and products for a fee.

Technical improvements include work on a computerized dispatching system; an upgraded computerized accounting system; improved internal management information system, and continuing research into improved operations.

The P&GJ 500... dimensions of the pipeline energy business

Rank 83	Rank 84	Name Of Company	Number Of Customers	1983 Gas Sales, MMcf	1983 Oper. Revenues \$(000)	1983 Net Income \$(000)	Gas Plant Value \$(000) 12-31-83	Additions To Plant \$(000)	Miles Of Mains	Miles Of Services
180	181	Pennsylvania & Southern Gas	14,800	5,237	28,831	N A	14,676	N A	463	207
182	182	Las Cruces Gas System	14,745	1,520	7,000	N A	N A	N A	350	167
186	183	Tennessee-Virginia Energy ^G	14,420	8,715	46,471	919	21,982	1,856	592	133
181	184	Chesapeake Utilities Corp.	14,346	1,980	11,746	N A	10,489	N A	312	168
187	185	Great Plains Natural Gas	14,016	3,032	17,503	426	6,698	368	318	224
185	186	Houma Municipal Gas System	14,013	3,846	N A	N A	N A	N A	156	132
184	187	Moran Utilities	13,851	1,473	10,691	N A	N A	N A	290	100
188	188	Richmond Gas Corp.	13,710	3,636	15,102	N A	N A	N A	214	158
189	189	Vermont Gas Systems	12,694	4,367	27,516	N A	11,481	N A	256	154
190	190	Lancaster Municipal Gas Co.	12,658	1,945	10,024	N A	N A	N A	281	111
194	191	Ft. Hill Natural Gas Authority ^J	12,440	3,307	16,577	N A	N A	N A	354	354
192	192	Charlottesville Gas Division	12,293	1,925	13,186	N A	N A	N A	199	171
195	193	Hobbs Gas Co.	12,203	1,676	8,179	N A	N A	N A	266	135 ^F
191	194	Warner Robbins Gas, City of ^K	12,100	3,571	16,125	617	5,343	46	195	115
196	195	Holyoke Gas & Electric	12,000	1,839	12,514	N A	N A	N A	127	71
193	196	Corning Natural Gas Corp.	11,876	12,471	60,949	523	8,384	260	102	237
198	197	Middle Tennessee Gas Util. Dist.	11,184	2,590	12,600	N A	N A	N A	615	349
197	198	Dalton Utilities	11,000	9,617	N A	N A	N A	N A	40	104
199	199	Clearwater, City of ^I	10,424	1,225	7,694	338	4,405	N A	325	118
201	200	Midwest Energy Inc.	10,291	1,967	7,589	1,025	2,519	139	225	126

The P&GJ 500... dimensions of the pipeline energy business

Rank 83	Rank 84	Name Of Company	Number Of Customers	1983 Gas Sales, MMcf	1983 Oper. Revenues \$(000)	1983 Net Income \$(000)	Gas Plant Value \$(000) 12-31-83	Additions To Plant \$(000)	Miles Of Mains	Miles Of Services
200	201	Citizens Gas Fuel	10,286	2,316	14,217	N A	N A	N A	210	185
206	202	Greenwood (S.C.) Public Works	10,037	2,800	13,328	794	7,322	281	297	151
202	203	Northwest Oklahoma Public Utilities	9,858	N A	N A	N A	N A	N A	316	92
204	204	Lynchburg Gas	9,710	5,284	29,129	754	9,405	714	357	194
203	205	Rocky Mount (N.C.) City of	9,700	2,177	N A	N A	11,031	231	148	177
205	206	Hastings Utilities	9,670	1,809	7,313	178	N A	N A	137	168
208	207	Illinois Gas Co.	9,360	1,569	5,994	N A	N A	N A	248	115
226	208	Peoples Natural Gas Co. of S.C.	9,353	3,082	19,515	538	5,817	789	211	199
210	209	Austin Utilities	9,230	2,738	10,612	N A	1,846	N A	143	88 ^F
215	210	Lake Apopka Natural Gas District ^I	9,128	1,012	4,995	628	2,497	96	283	82
213	211	Cedar Falls Utilities	9,110	1,614	7,649	N A	N A	N A	141	132
211	212	Pascagoula Gas System	9,059	N A	N A	N A	N A	N A	166	85
212	213	Pleasant Grove, City of	9,043	939	4,799	713	500	N A	224	112
209	214	Southern Public Service Co.	9,029	1,129	6,765	40	1,854	176	150	100
214	215	Superior Water, Light & Power Co.	8,847	1,856	11,448	467	6,356	52	115	117
225	216	Clinton-Newberry Gas Authority	8,800	1,608	9,042	N A	13,423	1,192	700	185
216	217	Henderson Municipal Gas Systems	8,659	1,599	8,125	N A	N A	N A	150	150
216	218	LaGrange Gas Dept., City of	8,570	2,000	1,900	N A	N A	N A	140	100
217	219	Vicksburg Water & Gas	8,344	1,028	5,620	N A	N A	N A	32	80
218	220	Norco Gas & Fuel Co. Inc.	8,312	979	6,322	-247	2,521	21	190	41
207	221	Marshall County Gas District	8,181	32	649	N A	N A	N A	251	96
221	222	Orangeburg Dept. of Public Utilities ^I	8,156	3,164	14,851	946	3,811	51	199	85
219	223	Florence Gas Department, City of ^I	8,133	1,207	7,419	164	3,773	626	280	250
220	224	Midwest Natural Gas	8,051	18,042	5,819	N A	N A	N A	118	122
246	225	Consumers Gas Utility Co.	7,546	920	5,715	219	1,359	670	370	78
222	226	SW Texas Municipal Gas Corp.	7,358	268	N A	N A	N A	N A	163	70
223	227	Tallahassee Municipal Gas System	7,353	1,143	6,971	N A	N A	N A	242	71
224	228	Norwich Dept. of Public Util.	7,196	883	7,379	506	6,289	213	107	N A
227	229	Owatonna Public Utilities	7,133	1,909	9,379	398	2,485	45	116	82
228	230	Schagrin Gas	7,000	N A	N A	N A	N A	N A	70	71
229	231	Del Rio Gas System, City of	6,975	476	N A	N A	N A	N A	163	66 ^F
230	232	Graysville Municipal Gas System ^F	6,900	565	3,309	153	3,361	N A	149	30
231	233	Dyersburg Municipal Gas System	6,863	1,341	N A	N A	N A	N A	260	65
233	234	Rio Grande Natural Gas Assoc.	6,691	533	2,282	N A	N A	N A	446	115
232	235	Houston DPW, Gas Division	6,682	494	2,324	N A	N A	N A	56	52
237	236	Liberal Gas Co.	6,500	1	2,800	N A	N A	N A	105	74
236	237	Phenix, Ala., Dept. of Public Util. ^I	6,490	1,321	6,421	185	4,495	300	152	89
238	238	Dixie Gas Co. Inc. ^F	6,392	497	3,285	-12	1,965	21	186	30
239	239	Westfield Gas & Electric Light	6,380	9,297	6,810	139	2,102	182	123	67
241	240	Wilson, City of	6,273	900	5,483	642	2,694	191	119	63
241	241	Gibson County Utility District	6,250	1,066	N A	N A	N A	N A	143	175
240	242	Missouri Edison	6,241	2,213	9,318	N A	N A	N A	144	72
243	243	Lawrenceville Natural Gas System	6,200	N A	N A	N A	N A	N A	130	59
243	244	Concord Natural Gas Corp.	6,155	1,159	8,412	197	4,270	828	153	82
244	245	Shenandoah Gas Co.	6,067	3,691	19,031	N A	N A	N A	145	88
242	246	Fultondale Gas Board, City of ^I	6,019	526	3,485	47	N A	N A	147	57
245	247	Gas Utilities Co., Ill.	5,892	7,540	20,737	N A	N A	N A	150	67
247	248	Watertown Gas Department	5,803	1,114	5,531	94	1,919	156	118	107
249	249	Bay City Gas Co.	5,730	389	N A	2,057	8,500	900	116	54
248	250	Cartersville Gas Dept.	5,720	2,250	1,856	N A	N A	N A	163	54

The P&GJ 500... dimensions of the pipeline energy business

Rank	Name Of Company	Number Of Customers	1983 Gas Sales, MMcf	1983 Oper. Revenues \$(000)	1983 Net Income \$(000)	Gas Plant Value \$(000) 12-31-83	Additions To Plant \$(000)	Miles Of Mains	Miles Of Services
251	Greenville Utilities Comm. ^f	5,600	946	6,241	550	3,220	460	127	61
250	252 Consumers Gas Co.	5,598	1,165	3,657	N A	N A	N A	88	102
251	253 Cullman-Jefferson Counties Gas Dist.	5,573	1,680	7,400	N A	N A	N A	60	350
253	254 Sylacauga Utilities Board	5,524	1,443	6,187	629	3,628	103	476	575
255	255 Elizabethtown Natural Gas	5,438	1,281	5,878	579	1,000	N A	132	100
256	256 Toledo Edison Co., The	5,369	1,234	7,014	72	5,800	242	106	80
254	257 Polaris Corp., The	5,302	399	2,281	N A	N A	N A	106	68
258	258 Carnegie Natural Gas Co.	5,295	21,545	83,038	3,355	42,746	451	91	N A
234	259 Leesburg Natural Gas Dept.	5,285	564	N A	N A	N A	N A	145	50
257	260 Thibodaux, City of	5,207	385	2,005	N A	N A	N A	79	49
265	261 Northwest Alabama Gas District	5,204	12,533	21,677	N A	N A	N A	276	203
258	262 Moss Point, City of	5,200	352	N A	N A	N A	N A	95	48
259	263 Bristol & Warren Gas Co. ¹¹	5,146	499	4,457	187	1,839	129	77	45
252	264 Morgan City Municipal Gas	5,096	395	2,550	139	1,615	1,604	80	53
260	265 Pike Natural Gas Co.	5,052	938	6,039	263	3,674	63	144	18
261	266 St. Augustine Gas, City of	5,012	N A	N A	N A	N A	N A	51	57
263	267 New Ulm Gas Dept.	4,933	1,565	7,069	N A	N A	N A	71	91
264	268 Milton, City of	4,896	3,286	N A	N A	N A	N A	154	56
266	269 Chanute, City of	4,833	763	N A	N A	N A	N A	38	46
271	270 Oak Ridge Utility District	4,824	788	3,165	N A	N A	N A	138	72
279	271 Ft. Pierce Utilities Authority	4,807	735	3,179	81	2,641	186	121	86
267	272 Fairhope Gas Department	4,781	482	1,156	N A	N A	N A	85	397
273	273 Wakefield Municipal Light Dept., Town of	4,734	322	2,534	245	1,146	127	64	23
270	274 Winfield, City of	4,609	808	2,290	N A	N A	N A	78	23
275	275 Central Florida Gas Corp.	4,600	48,442	17,619	345	3,052	218	281	83
276	276 Denham Springs, City of ^f	4,592	314	2,531	252	655	1	107	107
268	277 St. Joseph Light & Power	4,586	906	2,340	N A	N A	N A	126	47
269	278 Thomasville Water & Light	4,574	673	3,732	N A	N A	N A	141	44
275	279 Lexington Gas Dept., N.C.	4,568	2,280	10,413	N A	N A	N A	143	77
272	280 DeKalb-Cherokee Counties Gas	4,558	947	4,208	N A	N A	N A	171	43
273	281 Union Utility Dept.	4,518	1,407	5,837	N A	N A	N A	138	82
274	282 Lexington Gas System, Tenn.	4,516	1,917	N A	N A	N A	N A	67	43
276	283 West Tenn. Public Util. District	4,512	1,830	4,896	N A	N A	N A	314	130
277	284 Clarksville Gas Dept.	4,489	2,656	10,455	N A	N A	N A	216	43
280	285 Cody Gas	4,348	2,181	8,696	N A	N A	N A	205	41
284	286 Frederick Gas Co. Inc.	4,311	2,471	15,185	405	7,896	942	154	60
281	287 Shelby Gas Dept., City of	4,258	3,032	12,433	N A	N A	N A	111	81
296	288 Robstown Utility Systems	4,225	255	1,631	-180	N A	N A	54	12
282	289 Dumas, City of	4,200	448	N A	N A	N A	N A	71	40
278	290 Westlake Municipal Natural Gas	4,190	340	N A	N A	N A	N A	84	45
283	291 Indiana Natural Gas	4,173	873	3,237	N A	N A	N A	107	40
292	292 Eagle Pass Natural Gas Corp.	4,156	N A	N A	N A	N A	N A	N A	N A
293	293 Plaquemine Light & Water Plant	4,139	N A	N A	N A	N A	N A	53	39
285	294 Chambersburg Gas Dept.	4,135	1,053	3,438	N A	N A	N A	54	50
286	295 Toccoa, City of	4,117	615	3,067	N A	N A	N A	100	39
290	296 Nebraska City Utilities	4,107	710	3,307	236	3,000	39	73	208
297	297 Lake City Gas Co.	4,089	3,412	836	N A	N A	N A	141	140
287	298 Bluefield Gas Co.	4,081	1,010	5,321	N A	N A	N A	89	21
288	299 Ville Platte Gas System	4,080	342	2,523	N A	N A	N A	86	38
262	300 Decatur Utilities	4,054	5,931	26,566	334	7,327	297	159	87

The 100 Leading Gas Pipelines

The P&GJ 500... dimensions of the pipeline energy business

Rank 83	Rank 84	Name Of Company	Miles Of Pipelines				1983 Gas Sales, MMcf	1983 Oper. Revenues \$(000)	1983 Net Income \$(000)	Gas Plant Value \$(000) 12-31-83	Additions To Plant 1983 \$(000)
			Total	Transmission	Field, Gath.	Storage					
1	1	Northern Natural Gas Co.	23,101	14,609	8,287	205	589,721	2,673,229	107,093	1,020,465	54,834
2	2	El Paso Natural Gas Co.	21,687	9,337	12,332	18	876,000	4,122,887	54,886	1,793,993	-211,520
3	3	Columbia Gas Transmission Co.	18,570	10,512	6,827	1,231	771,043	3,860,155	92,022	2,031,328	73,159
4	4	Tennessee Gas Pipeline Co.	13,954	13,921	31	2	863,862	3,645,817	192,250	3,116,835	114,648
5	5	K N Energy, Inc.	13,213	10,350	2,842	21	75,527	273,684	12,538	363,041	22,021
6	6	Natural Gas Pipeline Co. of America ¹	12,765	10,830	1,839	96	921,206	3,010,990	130,201	895,861	114,907
7	7	Panhandle Eastern Pipe Line Co.	12,702	6,814	5,779	109	479,474	2,292,846	190,000	1,466,000	36,690
8	8	ANR Pipeline Co.	11,914	7,719	3,726	469	555,453	2,636,800	160,900	1,158,712	44,828
9	9	Lone Star Gas Co., (Enserch)	10,767	8,489	2,208	70	380,652	1,840,131	68,621	965,510	61,559
10	10	Transcontinental Gas Pipe Line	10,242	9,974	147	121	823,025	3,616,141	146,215	1,499,609	147,330
13	11	Texas Eastern Gas Pipeline Co.	9,784	9,538	48	198	967,437	3,146,927	230,274	2,326,689	59,648
12	12	Northwest Central Pipeline	9,748	5,835	3,733	180	287,787	1,043,039	43,404	566,839	15,256
14	13	Arkla, Inc.	9,583	6,019	3,521	43	265,849	1,045,836	129,907	1,540,729	129,533
11	14	United Gas Pipe Line Co.	9,564	7,336	2,200	28	586,476	2,645,257	68,275	452,917	331,827
15	15	Consolidated Gas Supply Corp.	8,205	3,600	4,195	410	497,399	2,374,965	90,516	1,080,927	81,108
17	16	Texas Oil & Gas Corp.	7,785	1,112	6,673	0	362,816	1,871,180	295,703	2,422,065	480,330
16	17	Southern Natural Gas Co.	7,675	7,487	140	48	504,961	2,052,562	212,209	1,456,136	47,383
18	18	Northwest Pipeline Corp.	6,628	3,467	3,154	7	282,000	1,601,832	152,963	1,293,839	97,000
19	19	Colorado Interstate Gas Co.	6,152	2,731	3,186	235	276,544	973,200	N/A	726,492	20,827
20	20	Texas Gas Transmission Corp.	5,937	5,669	51	217	536,589	2,047,370	53,851	317,110	23,254
28	21	Houston Natural Gas Corp. ⁶	5,509	3,274	2,200	35	515,564	2,258,831	256,121	775,853	31,675
21	22	Valero Transmission Corp.	5,328	4,039	1,289	0	250,100	1,200,473	24,264	461,394	10,586
22	23	Pacific Gas & Electric Co.	5,137	4,135	950	52	60,460	3,903,501	668,004	911,780	19,956
32	24	National Fuel Gas Supply Corp.	4,793	2,381	1,927	485	156,423	1,011,291	56,452	144,605	8,400
24	25	Peoples Natural Gas, (Internorth)	4,698	3,979	719	0	123,359	553,934	9,558	135,762	12,642
23	26	ONEOK, Inc.	4,624	4,602	0	22	278,074	970,360	58,678	602,341	4,443
25	27	Trunkline Gas Co.	4,477	3,932	520	25	605,716	1,466,670	58,664	956,145	18,087
27	28	Transwestern Pipeline Co.	4,395	4,395	0	0	277,911	1,136,426	30,336	65,506	41,099
26	29	Florida Gas Transmission Co.	4,322	4,322	0	0	194,023	700,711	30,745	173,380	12,727
30	30	Columbia Gulf Transmission Co.	4,180	2,543	1,637	0	675,091	209,451	40,635	1,022,715	6,366
29	31	Pioneer Corp. (Westar Trans. Div)	4,176	3,405	771	0	169,134	622,451	N/A	51,481	6,632
31	32	Montana-Dakota Utilities Co.	4,122	3,096	875	151	45,307	218,956	9,125	325,712	57,315
35	33	Mitchell Energy & Devel. Corp.	3,700	3,700	0	0	54,750	930,708	72,778	N/A	10,547
36	34	Montana Power Co.	2,894	1,876	964	54	352,435	88,590	276,797	5,998	31,439
34	35	Mustang Fuel Co.	2,814	908	1,901	5	N/A	N/A	N/A	N/A	N/A
37	36	North Carolina Natural Gas Corp. ¹	2,755	854	1,901	0	33,168	166,472	3,263	58,964	4,625
42	37	United Texas Transmission Co.	2,642	2,215	427	0	201,533	1,135,476	36,804	447,521	66,490
38	38	East Ohio Gas Co.	2,463	1,270	935	258	N/A	N/A	N/A	N/A	N/A
39	39	Michigan Consolidated Gas Co.	2,348	2,186	52	110	N/A	N/A	N/A	N/A	N/A
40	40	Peoples Natural Gas Co. (Pa.)	2,340	1,034	1,267	39	N/A	N/A	N/A	N/A	N/A
41	41	Southern California Gas Co.	2,316	2,272	0	44	523,515	4,499,508	110,025	276,036	15,242
41	42	Mississippi River Trans. Co.	2,223	1,970	178	75	153,296	716,000	N/A	333,000	10,000
46	43	Western Slope Gas Co.	2,122	1,652	450	20	50,931	212,401	3,985	81,365	6,882
43	44	Equitable Gas Co.	2,114	478	1,506	130	63,982	359,173	51,969	461,415	21,864
44	45	Kentucky-West Virginia Gas Co.	2,106	28	2,078	0	20,954	105,868	17,362	107,542	5,077
46	46	Texas Utilities Fuel Co.	2,080	2,080	0	0	225,105	741,318	28,095	204,784	N/A
45	47	Transok, Inc.	2,075	792	1,283	0	138,000	157,461	15,468	168,470	10,886
47	48	Mountain Fuel Supply Co.	2,063	1,330	723	10	121,021	483,029	33,158	668,979	625,042
49	49	Producer's Gas Co.	1,924	579	1,345	0	76,211	325,992	68,553	11,124	1,814
49	50	Louisiana Intrastate Gas Corp.	1,882	1,882	0	0	N/A	N/A	N/A	N/A	N/A

The P&GJ 500...dimensions of the pipeline energy business

Rank 83	84	Name Of Company	Miles Of Pipelines				1983 Gas Sales, MMcf	1983 Oper. Revenues \$(000)	1983 Net Income \$(000)	Gas Plant Value \$(000) 12-31-83	Additions To Plant 1983 \$(000)
			Total	Transmission	Field, Gath.	Storage					
51	51	South Carolina Electric & Gas Co.	1,653	1,653	0	0	65,892	337,282	103,938	137,647	12,660
	52	Exxon Gas System	1,469	1,469	0	0	14,399	118,210	32,164	51,600	0
50	53	Southwest Gas Corp.	1,460	1,454	6	0	64,014	384,860	16,651	256,639	20,133
53	54	Central Illinois Public Service	1,396	1,372	14	10	N/A	N/A	N/A	N/A	N/A
54	55	Great Lakes Gas Trans. Co.	1,305	1,305	0	0	33,581	312,307	17,471	519,834	9,815
48	56	Consumers Power Co.	1,296	1,165	21	110	273,242	1,399,984	79,396	210,675	3,215
55	57	Carnegie Natural Gas Co.	1,174	256	918	0	21,545	83,038	4,220	80,916	5,862
56	58	Clajon Gas Co.	1,130	30	1,100	0	N/A	N/A	N/A	N/A	N/A
57	59	Northern Utilities Inc.	1,028	1,005	23	0	17,810	82,798	1,980	31,192	-2,698
58	60	East Tennessee Natural Gas Co.	1,012	1,012	0	0	74,945	317,471	7,530	78,224	2,442
59	61	Tejas Gas Corp.	996	996	0	0	85,571	94,502	5,236	43,116	8,403
60	62	Pacific Lighting Gas Supply Co.	985	903	0	82	289,984	1,279,727	20,638	250,088	11,791
62	63	Arkansas Western Gas Co.	965	693	268	4	15,800	68,499	3,248	36,110	6,397
63	64	Algonquin Gas Trans. Co.	930	930	0	0	174,384	750,897	14,534	120,260	1,259
64	65	Midwestern Gas Transmission Co.	915	903	0	12	156,969	780,263	8,741	159,583	2,128
65	66	North Penn Gas Co.	890	587	290	13	21,812	91,597	1,669	34,548	1,897
68	67	Pacific Gas Trans. Co.	840	799	41	0	247,652	1,229,414	25,609	191,133	8,651
67	68	Mid Louisiana Gas Co.	833	408	425	0	26,462	110,556	16,202	73,821	4,978
66	69	Northern Border Pipeline Co.	822	822	0	0	N/A	384,400	79,100	1,191,700	10,700
69	70	South Georgia Natural Gas Co.	769	769	0	0	24,278	99,014	592	21,451	1,206
71	71	Michigan Gas Storage Co.	717	569	0	148	75,227	309,995	2,495	53,529	810,784
78	72	Channel Industries Gas Co.	640	640	0	0	N/A	N/A	N/A	N/A	N/A
	73	Riverway Gas Pipeline Co.	613	613	0	0	60	N/A	N/A	N/A	N/A
72	74	Public Service Co. of N.C. Inc.	607	607	0	0	43,808	247,317	8,254	137,089	8,174
73	75	Northern Gas Co.	607	555	38	14	9,009	45,421	N/A	17,689	N/A
74	76	Associated Natural Gas Co.	602	602	0	0	10,960	57,255	2,372	38,135	1,380
76	77	Commonwealth Gas Pipeline Corp.	559	559	0	0	69,443	279,227	3,254	49,048	9,124
77	78	Perry Gas Co.'s	555	0	555	0	N/A	N/A	N/A	N/A	N/A
61	79	Arkansas Oklahoma Gas Corp.	551	380	168	3	12,077	38,977	1,427	41,521	2,853
79	80	Monterrey Pipeline Co.	550	550	0	0	N/A	N/A	N/A	N/A	N/A
80	81	Inland Gas Co. Inc.	530	394	136	0	6,908	29,642	-2,163	23,026	560
75	82	Valero Interstate Trans. Co.	529	273	256	0	21,585	82,521	2,214	22,461	902
81	83	Washington Gas Light Co.	519	501	18	0	111,622	815,666	30,575	489,148	31,669
83	84	Southeast Alabama Gas Dist.	470	470	0	0	6,980	31,291	N/A	N/A	N/A
86	85	Seagull Pipeline Corp.	453	453	0	0	85,100	73,478	12,081	10,083	32
84	86	Sea Robin Pipeline Co.	448	448	0	0	147,536	431,137	18,571	62,571	33
85	87	Dow Pipeline Co.	398	398	0	0	328	126,674	8,307	13,671	N/A
98	88	Amoco Gas Co.	393	281	112	0	N/A	N/A	N/A	N/A	N/A
87	89	MGTC, Inc.	374	364	10	0	3,654	18,270	219	6,878	2,154
89	90	Esperanza Transmission Co.	365	365	0	0	28,893	116,139	6,445	12,286	1,159
91	91	Red River Pipeline Co.	360	360	0	0	N/A	N/A	N/A	N/A	N/A
	92	Piedmont Natural Gas Co. Inc.	354	354	0	0	60,924	346,503	19,097	20,229	2,764
94	93	Palo Duro Pipeline Co.	354	354	0	0	N/A	N/A	3,400	14,600	N/A
92	94	Stingray Pipeline Co.	334	334	0	0	267,192	46,774	15,844	237,294	2,301
91	95	Winnie Pipeline Co.	333	333	0	0	N/A	N/A	N/A	N/A	N/A
93	96	Ala.-Tenn. Natural Gas Co.	316	314	2	0	31,497	137,732	6,124	20,549	471
95	97	Louisville Gas & Electric Co.	307	178	0	129	48,276	230,597	59,698	91,771	4,819
	98	Howell Pipeline Co. (Ala.)	300	45	255	0	N/A	N/A	N/A	N/A	N/A
97	99	Western Gas Interstate Co.	296	243	53	0	4,674	15,421	-273	6,463	706
88	100	Mountain Fuel Resources	288	159	129	0	6,551	31,969	4,209	51,699	739

The 100 Leading Liquid Pipelines

The P&GJ 500... dimensions of the pipeline energy business

Rank	84	Name of Company	Delivered out of system in 1983 Bbl (000)			1983 Financial		Property Value \$(000) 12-31-83	Changes in Prop. Val. \$(000)	Miles Of Lines Owned/Operated			
			Total	Crude Oil	Products	Oper. Rev. \$(000)	New Income \$(000)			Gath. Lines	Crude Trunk	Products Trunk	Total
1	1	Arco Pipe Line Co. ^Q	655,650	503,252	152,398	895,332	290,457	2,430,835	19,352	1,698	2,561	3,778	8,037
2	2	Colonial Pipeline Co.	586,174	0	586,174	475,395	121,561	1,314,417	1,164	0	0	5,248	5,248
3	3	Exxon Pipeline Co. ^Q	568,222	457,016	111,206	890,345	325,572	2,413,836	24,182	1,886	4,811	2,399	9,096
13	4	Marathon Pipe Line Co.	543,641	348,658	194,983	127,054	32,359	331,746	1,028	1,025	1,697	1,381	4,103
4	5	Shell Pipe Line Corp.	499,183	372,956	126,227	144,649	42,300	427,781	9,295	2,002	4,658	416	7,076
5	6	Gulf Pipeline Co.	451,213	253,956	197,257	115,564	35,023	284,221	12,796	1,947	1,048	2,041	5,036
10	7	Texas Pipe Line Co.	414,145	286,263	127,882	101,533	29,502	273,040	12,676	1,239	2,516	710	4,465
7	8	Lakehead Pipe Line Co.	404,233	404,233	0	188,713	52,809	442,286	3,738	0	2,599	0	2,599
9	9	Sohio Pipe Line Co. ^Q	347,077	303,501	43,576	1,251,854	406,607	3,302,932	9,917	1,069	612	142	1,823
6	10	Amoco Pipeline Co.	334,747	322,830	11,917	197,853	75,458	501,407	16,264	2,267	7,956	2,049	12,272
8	11	Mobil Pipe Line Co. ^Q	317,881	199,998	117,883	155,184	58,411	286,517	-2,571	4,331	5,100	1,719	11,150
11	12	Buckeye Pipe Line Co.	274,009	20,122	253,887	109,177	21,267	351,414	7,539	0	126	3,332	3,458
12	13	Phillips Pipe Line Co.	267,453	86,362	181,091	126,637	24,776	309,819	-23,997	1,077	807	3,731	5,615
14	14	Southern Pacific Pipe Line Co.	243,355	0	243,355	82,735	28,481	100,810	7,830	0	0	2,517	2,517
15	15	Continental Pipe Line Co.	228,207	177,618	50,589	68,764	30,273	165,264	5,926	4,036	1,523	1,811	7,370
16	16	Chevron Pipe Line Co.	203,000	166,000	37,000	86,724	26,651	204,189	4,911	214	1,501	1,490	3,205
18	17	Williams Pipe Line Co.	172,889	4,479	168,410	139,002	37,226	521,445	66,859	0	82	8,365	8,447
21	18	Plantation Pipe Line Co.	162,303	0	162,303	98,932	22,427	287,579	842	0	0	3,158	3,158
17	19	Sun Pipe Line Co.	160,300	61,300	99,000	58,446	24,756	130,710	1,170	498	801	1,894	3,193
20	20	Texas-New Mexico Pipeline Co.	147,493	147,493	0	35,299	8,479	87,965	305	1,814	2,207	0	4,021
30	21	Loop Inc.	141,042	141,042	0	52,176	4,373	835,923	28,151	0	52	0	52
24	22	Mid-America Pipeline Co.	138,414	0	138,414	85,146	36,045	429,720	4,660	0	0	8,233	8,233
19	23	CITGO Pipeline Co.	136,151	135,198	953	21,922	6,005	44,095	-19,458	622	899	105	1,626
23	24	West Texas Pipe Line Co.	125,812	125,812	0	28,844	9,978	45,142	163	0	581	0	581
22	25	Texas Eastern Prod. Pipeline Co.	124,643	0	124,643	139,805	N/A	433,500	34,285	0	0	4,120	4,120
27	26	Explorer Pipeline Co.	124,577	0	124,577	52,512	9,563	250,110	213	0	0	1,397	1,397
25	27	Mid-Valley Pipeline Co.	122,923	122,923	0	50,750	12,995	115,390	780	0	1,097	0	1,097
31	28	Locap Inc.	118,429	118,429	0	13,917	N/A	121,429	N/A	0	58	0	58
28	29	Pure Transportation Co.	118,357	94,711	23,646	32,276	8,570	81,730	1,194	799	713	12	1,524
26	30	Four Corners Pipe Line Co.	118,063	97,937	20,126	41,102	1,814	146,193	6,786	284	1,202	24	1,510
29	31	BP Pipeline Inc.	98,729	98,729	0	546,758	185,069	1,606,522	7,841	0	818	0	818
32	32	Ashland Pipe Line Co.	80,683	80,683	0	31,655	7,198	92,197	2,244	432	787	0	1,219
33	33	Wolverine Pipe Line Co.	75,530	0	75,530	20,814	3,985	71,232	108	0	0	620	620
35	34	Olympic Pipeline Co.	74,774	0	74,774	22,612	6,312	57,240	499	0	0	391	391
36	35	Chicap Pipe Line Co.	71,175	71,175	0	11,656	3,276	38,672	116	0	235	0	235
40	36	Badger Pipe Line Co.	68,343	0	68,343	12,410	2,606	24,178	8	0	0	328	328
34	37	Lake Charles Pipe Line Co.	67,572	0	67,572	4,374	1,190	10,369	2	0	0	13	13
37	38	Platte Pipe Line Co.	67,187	67,187	0	38,375	11,999	73,932	2,447	0	1,280	0	1,280
42	39	Wesco Pipe Line Co.	65,675	65,675	0	18,265	763	70,631	4,640	499	570	0	1,069
38	40	West Shore Pipe Line Co.	63,059	0	63,059	14,696	3,621	33,128	452	0	0	322	322
39	41	Owensboro-Ashland Co.	60,004	0	60,004	9,308	1,791	43,514	26	0	295	0	295
41	42	Minnesota Pipe Line Co.	57,769	57,769	0	17,624	3,988	34,952	6,077	0	394	0	394
45	43	Seaway Pipeline Inc.	50,495	50,495	0	10,455	-14,294	209,096	93	0	515	0	515
47	44	Shamrock Pipe Line Corp.	43,953	28,200	15,753	13,543	6,631	23,950	1,284	637	316	544	1,497
81	45	American Petrofina Pipe Line ^H	43,669	32,995	10,674	11,625	3,838	41,189	13,622	171	1,067	74	1,312
48	46	Kaneb Pipe Line Corp.	40,602	0	40,602	28,639	5,123	90,616	1,602	0	0	1,673	1,673
44	47	Southcap Pipe Line Co.	40,005	40,005	0	11,869	1,953	53,552	181	0	0	0	0
50	48	Texoma Pipe Line Co.	38,595	38,595	0	15,019	-4,819	157,945	853	0	504	0	504
51	49	Total Pipeline Corp.	38,284	26,591	11,693	6,830	470	23,429	469	231	436	64	731
53	50	Collins Pipeline Co.	36,919	0	36,919	3,845	1,167	14,319	N/A	0	0	124	124

The P&GJ 500... dimensions of the pipeline energy business

Rank 83	84	Name of Company	Delivered out of system in 1983 Bbl (000)			1983 Financial		Property Value \$(000) 12-31-83	Changes In Prop. Val. \$(000)	Miles Of Lines Owned/Operated			
			Total	Crude Oil	Products	Oper. Rev. \$(000)	New Income \$(000)			Gath. Lines	Crude Trunk	Products Trunk	Total
54	51	Santa Fe Pipe Line Co.	36,689	0	36,689	20,445	6,717	48,231	420	0	0	899	899
52	52	Dome Pipeline Corp.	34,679	0	34,679	6,171	12,436	22,039	44	1	8	130	139
57	53	Butte Pipeline Co.	34,573	34,573	0	11,264	3,299	18,092	385	0	373	0	373
56	54	Dixie Pipeline Co.	33,687	0	33,687	38,487	8,802	72,659	804	0	0	1,303	1,303
59	55	Jayhawk Pipeline Corp.	31,956	31,956	0	6,724	1,162	21,265	200	237	513	0	750
43	56	Texaco-Cities Serv. Pipe Line Co.	30,767	30,767	0	5,113	5,343	35,663	-18,696	0	34	0	34
55	57	Hydrocarbon Trns. Inc.	30,600	0	30,600	37,896	10,411	131,232	1,192	0	0	1,537	1,537
78	58	Seminole Pipeline Co.	30,233	0	30,233	19,504	3,459	202,343	982	0	0	787	787
61	59	Hess Pipeline Co.	29,449	29,449	0	9,314	1,275	50,850	734	427	0	0	427
62	60	Belle Fourche Pipeline Co.	29,125	29,125	0	16,902	7,223	49,425	1,882	1,039	729	0	1,768
49	61	Portland Pipe Line Corp.	28,150	28,150	0	21,896	6,800	53,896	776	0	510	0	510
60	62	Osage Pipe Line Co.	26,373	0	26,373	5,363	1,234	19,590	N/A	0	136	0	136
58	63	Laurel Pipe Line Co.	26,371	0	26,371	10,851	1,324	56,838	-594	0	0	453	453
	64	San Diego Pipeline Co.	25,344	0	25,344	6,199	335	8,366	285	0	0	122	122
63	65	Cochin Pipeline System	25,157	0	25,157	72,128	47,734	239,732	-1,022	0	0	1,170	1,170
65	66	Mobil Alaska Pipeline Co.	24,771	24,771	0	153,459	60,799	395,784	1,789	0	818	0	818
66	67	Portal Pipe Line Co.	23,707	23,707	0	18,192	7,298	31,643	260	551	0	47	598
68	68	Calnev Pipe Line Co.	22,742	0	22,742	14,146	7,712	33,560	2,194	22	65	566	653
67	69	Oiltanking of Texas Pipeline Co.	22,317	22,317	0	1,862	815	11,300	40	0	19	0	19
80	70	Kenai Pipe Line Co.	21,000	21,000	0	4,511	1,232	12,453	95	0	23	0	23
69	71	Paloma Pipe Line Co.	20,260	20,260	0	1,956	327	5,827	N/A	0	112	0	112
71	72	Yellowstone Pipeline Co.	20,163	0	20,163	10,328	2,563	28,451	292	0	0	749	749
75	73	Tecumseh Pipe Line Co.	20,038	20,038	0	2,805	667	15,286	12	0	206	0	206
72	74	Diamond Shamrock Corp.	20,016	0	20,016	16,121	3,839	32,287	N/A	0	0	622	622
73	75	Farmland Industries Inc.	19,705	19,705	0	2,894	817	10,494	-15	647	239	0	886
77	76	Wyco Pipe Line Co.	19,020	0	19,020	13,073	4,064	25,200	283	0	0	677	677
70	77	Cook Inlet Pipe Line Co.	18,763	18,763	0	23,065	6,204	42,352	8	0	55	0	55
74	78	Kaw Pipe Line Co.	18,606	18,606	0	5,844	1,111	12,086	243	1,394	0	0	1,394
	79	Golden Valley	16,625	16,625	0	757	85	4,673	0	0	3	0	3
76	80	Chase Transportation	14,318	0	14,318	7,674	4,634	38,330	63	0	0	698	698
79	81	Ohio River Pipe Line Co.	13,190	0	13,190	5,830	1,235	21,951	274	0	0	400	400
82	82	Okie Pipe Line Co.	12,688	7,805	4,883	5,816	1,893	14,424	474	498	0	409	907
85	83	Gulf Central Pipeline Co.	12,426	0	12,426	23,520	6,659	121,222	246	0	0	1,912	1,912
89	84	Chisholm Pipeline Co.	12,294	0	12,294	4,962	1,962	18,854	1,887	0	0	203	203
100	85	Interstate Energy Co.	11,152	0	11,152	16,773	0	55,245	61	0	0	94	94
83	86	Allegheny Pipeline Co.	10,960	0	10,960	5,698	1,924	27,791	82	0	0	603	603
84	87	Acorn Pipeline Co.	10,744	10,744	0	3,120	1,060	3,356	0	0	0	0	0
86	88	Pioneer Pipeline Co.	10,663	0	10,663	4,343	802	12,583	256	0	0	301	301
91	89	Cenex Pipeline Dept.	10,576	431	10,145	4,314	N/A	13,215	863	0	47	423	470
92	90	Kiantone Pipeline Corp.	9,264	9,264	0	1,958	46	13,193	143	0	78	0	78
93	91	Trans-Ohio Pipeline Co.	9,190	0	9,190	2,677	924	13,843	0	0	0	133	133
90	92	Jet Lines, Inc.	9,153	0	9,153	3,838	811	12,118	16	0	0	111	111
94	93	Amerada Hess Pipeline Corp.	9,034	9,034	0	58,072	24,998	148,339	516	0	0	0	0
99	94	Mobil Eugene Island Pipeline Co. Q	8,811	8,811	0	8,218	3,033	26,335	2	0	0	0	0
96	95	Phillips Alaska Pipeline Co. Q	8,111	8,111	0	50,386	20,882	125,676	465	0	0	0	0
97	96	Union Alaska Pipe Line Co. Q	8,091	8,091	0	49,139	18,028	125,828	907	0	0	0	0
	97	Black Lake Pipe Line Co.	4,017	4,017	0	1,541	170	10,050	0	0	255	0	255
98	98	TransMountain Oil Pipe Line Corp.	3,692	3,692	0	892	351	6,724	-19	0	64	0	64
95	99	Midland-Lea Pipeline Co.	2,909	590	2,319	4,893	681	20,052	832	0	101	275	376
	100	West Emerald Pipe Line Corp.	1,975	0	1,975	879	237	6,721	-2	0	0	296	296

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**International
Pipeline Forecast
Construction Report**

**Marketing: New Horizons
For Gas Sales**

Odorization Update

International Pipeline & Gas Utility Design, Construction & Operation

Natural gas from the Norwegian sector of the North Sea comes ashore at Karstø in tunnel in the Statpipe gas line from Statfjord Field. The gas is processed and gas liquids removed, then sent on its way to Ekofisk platforms in the southern part of the North Sea through a companion pipeline, which goes back to sea through the same tunnel. Cut through solid rock, tunnel takes place of conventional buried landfill. — photo courtesy NACAP.



ON THE COVER

There are 101,577 miles of planned and underway crude oil, refined products, NGL, LPG, and natural gas pipelines around the world, outside the U.S. During 1984, contractors will install 12,353 miles of pipelines internationally. For 1985, the forecast is for 12,500 miles or more. Special report, page 16, provides details and both area-by-area and country-by-country breakdowns.



IN THIS ISSUE

Getting ready for winter is a year-around job for the nation's gas distribution utilities and gas transmission pipelines. It involves both planned maintenance/renovation/replacement and tasks that result from last winter's operations. In November, special reports from gas companies deeply involved in "winterization" tell how it's done and how to do it, complete with checklists.



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101,577 Miles Of Pipelines Planned Or Underway International Pipelines

International pipeline construction activity in 1985 should be equal to or better than 1984, a year when a total of 12,325 miles of crude oil, products, gas liquids, and natural gas pipelines will be installed worldwide.

The 1984 global pipeline construction figures (all areas outside the U.S.) include 7,851 miles of gas pipelines; 2,381 miles of crude oil pipelines; 1,435 miles of refined products, LPG, and NGL pipelines; and 658 miles of offshore oil and gas pipelines.

As of October 1, 1984 there were 101,577 miles of planned and underway pipelines internationally. This includes 70,861 miles of planned and underway natural gas pipelines; 18,263 miles of planned and under construction crude oil lines; 9,893 miles of planned and being built products, LPG, and gas liquids pipelines; 2,246 miles of slurred solids lines, and 324 miles of carbon dioxide pipelines.

Of the total pipelines underway or planned, 17% are in Europe; 17% are in South America; 14% are in the Eastern Bloc, China, or U.S.S.R.; 13% are in Africa; 12% are in the Middle East; 9% are in Canada; 9% are in Southeast Asia; 4% are in Australia and New Zealand; 3% are in Mexico and Central America, and 2% are in the Pacific Area that includes Japan, Korea, Taiwan, and the Philippines.

Early indications are that 12,500 miles of international pipelines will be installed during 1985. That figure, of course, can

and probably will be altered by political and energy economics considerations.

Worldwide, economic conditions began improving during 1984 and demand for energy increased. Lesser developed countries are again seeking energy by pipeline, either from resources within their own borders or from nearby areas.

Political considerations in the Middle East have resulted in development of several major pipeline construction projects. Some could even be considered "super projects" based on their length, diameter, and estimated cost.

Several big projects reached the completion stage in 1984, including the Norwegian Statpipe system in the North Sea, where pipelaying was finished early in the summer ahead of schedule; completion in early 1984 of the 926-mile Dampier-to-Perth gas pipeline in Western Australia (the line is now being filled for operation); and completion of a 42-in. section of the Trans-Med Gas Pipeline from near Rome to Minerbio in northern Italy.

Of the 101,577 miles of planned and underway pipelines around the globe, 86% are in countries in the free world.

Of the more than 85,000 miles of free world underway and planned lines, 72% are natural gas, 17% are crude oil, and 11% are products lines.

Planned lines account for 90% of the total; 10% are under construction.

Of the lines under construction, 68%

SPECIAL REPORT

by DEAN HALE, Editor

INTERNATIONAL PIPELINE CONSTRUCTION*

(As of October 1, 1984)

Type of Line	Miles		
	Total	Underway	Planned
Natural Gas	70,861	8,162	62,699
Crude Oil	18,263	2,304	15,959
Products	9,893	1,614	8,279
Slurry	2,246	5	2,241
Carbon Dioxide	324	0	324
TOTALS	101,577	12,085	89,492

*Includes all free world (outside U.S.) plus Soviet Bloc and China

1984 International Pipeline Construction

(Estimated Miles Completed During 1984)

Gas Transmission	6,751
Gas Field and Gathering Lines	1,100
TOTAL	7,851
Crude Trunk Lines	1,771
Crude Gathering Lines	610
TOTAL	2,381
Products Lines	615
NGL/LPG Lines	820
TOTAL	1,435
Offshore Gas Lines	498
Offshore Oil Lines	160
TOTAL	658
GRAND TOTAL	12,325

THE WORLD PIPELINE OUTLOOK

Planned or Under Construction Projects
(As of October 1, 1984)

	In Miles								Total
	GAS PIPELINES		CRUDE PIPELINES		PRODUCTS PIPELINES		TOTALS		
	Planned	U/C	Planned	U/C	Planned	U/C	Planned	U/C	
Canada	8,211	230	65	431	155	145	8,431	806	9,237
Europe & North Sea	14,402	1,855	597	48	84	89	15,083	19,921	17,075
Middle East	4,836	189	4,076	410	2,238	—	11,150	599	11,749
Africa	5,259	1,090	2,299	1,001	1,910	935	9,468	3,026	12,494
S.E. Asia	6,647	419	1,429	—	767	100	8,843	519	9,362
Australia, N. Zealand	3,072	128	280	—	227	—	3,579	128	3,707
Mexico & Cent. Amer	624	392	804	—	784	175	2,212	567	2,779
South America	12,353	584	2,355	—	1,289	170	15,997	754	16,751
Pacific	1,240	—	454	—	440	—	2,144	—	2,144
U.S.S.R. East Bloc & China	6,055	3,275	3,600	414	375	—	10,030	3,689	13,719
TOTALS	62,699	8,162	15,959	2,304	8,279	1,614	86,927	12,080	99,007

are gas pipelines, 19% are crude oil lines, and 13% are products lines.

Of the total planned, 73% are natural gas, 18% are crude oil, and 9% are products lines.

Major Projects. Big pipeline projects make news and there has been a lot of activity in recent months.

A major study of Europe's energy requirements and natural gas supplies from now to the end of the century was made by Purvin & Gertz, consulting energy engineers. The P&G study found that from 1984 to 1990, there will be an excess of supply over demand.

By 1995, a shortfall of 42 million tons of oil equivalent (MTOE) can be expected, and that will increase to 86 MTOE by the year 2000. P&G believes the shortfall will be covered by increased western Europe gas production and additional gas from the North Sea in the early stages, and by increased imports from Algeria, U.S.S.R., and Libya in the 1995 to 2000 period. P&G does not believe that gas from Nigeria or the Middle East will be piped to Europe.

Eastern Bloc countries suffering from reduced oil exports from Russia may eventually be compensated with more natural gas from Soviet pipelines. The U.S.S.R. recently made such a proposal to its satellites. The Soviet Union also has announced plans to triple gas deliveries to Finland, reaching 106 Bcf by the century's end.

Loop of the Algerian section of the 1,563-mile Trans-Med gas pipeline to and through Italy has been announced by Algeria's Sonatrach. A letter of intent on 342-miles of 48-in. parallel line in Algeria has been given to Saipem.

Now that Norway's Statoil is getting ready to commission (by year's end) the Statpipe system in the North Sea, it is looking at alternatives to moving gas from the far, far northern Askeladden Field on Tromsøflaket where 6.18 Tcf has been found. Statoil says more gas needs to be found there to supply a major pipeline (south through Sweden) to the continent. (At 1 Bcf per day, the field now could supply a pipeline for 16.9 years.)

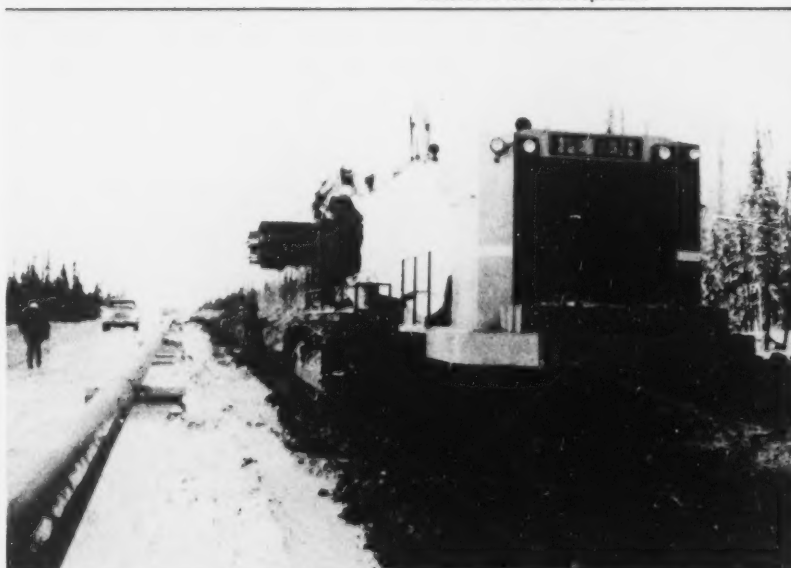
Statoil is studying the possibility of liquefying the gas and transporting it as LNG in tankers to the continent or even to the U.S.

Canada's energy posture is expected to improve materially with a newly elected government that has suggested it will stress development of oil and gas re-



In Iran, Saipem is completing work on the IGAT II gas pipelines. Scheduled finish date is February 1985, seven years after project was begun (March 1978).

In Canada, Arctic trenchers on Norman Wells oil pipeline could cut up to 5 miles/day in muskeg, but met their match in boulder-filled permafrost of northern spreads.



In Auckland, N.Z., products and natural gas pipelines were laid in the same trench under city streets as part of recent project.



sources and export of same to stimulate income. Coupled to that are two recent and important announcements – one by the Polar Gas Project on a new 1,340-mile, 36-in. pipeline route from the Mackenzie Delta and the Beaufort Sea to Alberta; the other is a recommendation by an environmental assessment commission that a 16-in. crude oil line might be built to take up to 100,000 b/d of oil from the Beaufort Sea area to southern markets.

European developments. British Gas Corp. plans to install 48 miles of 24-in. and 35 miles of 42-in. in 1985, plus numerous other smaller projects not yet formalized.

Denmark's Dansk Olie & Natur Gas (DONG) plans 104 miles of 12-, 16-, and 20-in. pipeline. Work on 7,000 miles of gas distribution laterals is getting underway by Denmark's five regional gas distribution organizations.

In France, Gaz de France reportedly will install 88 miles of 18- to 30-in. in early 1985.

In West Germany, work is progressing on 273 miles of 44-in. gas lines for the MEGAL system. Another 52 miles are scheduled to get underway in 1985.

In Sweden, 186 miles of 24- and 36-in. gas pipeline are planned from Malmo to Halsted.

Spain abounds with plans for gas pipe-

lines—some 1,770 miles are projected and nearly every area of the country is covered.

Africa. Work on the White Nile pipeline project, dual 935-mile lines – one a 10- and 12-in. products line, the other a 20- and 22-in. crude oil line – has partially resumed with right-of-way clearing. If rebel unrest is contained by government forces, construction of the pipeline might get underway in early 1985.

Details on the proposed Trans-Africa Pipeline Project, 2,299 miles of 36-in. crude oil pipeline across the middle of Africa, continue to leak out. Line's oil would come from the terminal at Yanbu al Bahr in Saudi Arabia, transported by ship

WORLD PIPELINES – PLANNED AND UNDER CONSTRUCTION – BY COUNTRY

(As of October 1, 1984)

	Gas Pipelines		Crude Pipelines		Products Pipelines		Country Totals		Total
	Planned	U/C	Planned	U/C	Planned	U/C	Planned	U/C	
Abu Dhabi	200	—	200	—	—	—	400	—	400
Algeria	1,465	459	—	—	—	—	1,589	459	2,048
Argentina	5,493	393	435	—	392	—	6,320	393	6,713
Australia	2,891	—	248	—	227	—	3,366	—	3,366
Austria	240	—	—	—	—	—	240	—	240
Bangladesh	1,350	57	—	—	—	—	1,350	57	1,407
Belgium	16	21	—	—	—	—	16	21	37
Bolivia	1,437	—	—	—	405	—	1,842	—	1,842
Brazil	3,818	191	517	—	—	—	4,335	191	4,526
Bulgaria	—	—	—	—	—	—	—	—	—
Burma	50	—	—	—	—	—	50	—	50
Cameroon	—	—	2,299	—	—	—	2,299	—	2,299
Canada	8,211	230	65	431	155	145	8,431	806	9,237
Chad	—	—	—	—	—	—	—	—	—
Chile	424	—	—	—	168	—	582	—	582
China	1,875	331	2,725	174	375	—	4,975	505	5,480
Colombia	360	—	590	—	—	170	950	170	1,120
Congo	—	—	—	—	—	—	—	—	—
Costa Rica	—	—	110	—	—	—	110	—	110
Czechoslovakia	—	528	—	—	—	—	—	528	528
Denmark	7,651	—	—	—	—	—	7,651	—	7,651
Dubai	—	—	—	—	—	—	—	—	—
E. Germany	—	—	—	—	—	—	—	—	—
Ecuador	135	—	286	—	324	—	745	—	745
Egypt	536	277	—	66	—	—	536	343	879
France	1,015	—	350	—	—	—	1,365	—	1,365
Greece	115	—	—	—	—	—	115	—	115
Guatemala	—	—	200	—	—	—	200	—	200
Honduras	—	—	160	—	—	—	160	—	160
Hungary	372	—	—	—	—	—	372	—	372
India	1,440	135	342	—	336	—	2,118	235	2,353
Indonesia	1,891	—	121	—	—	—	2,012	—	2,012
Iran	(n.a.)	—	—	—	—	—	—	—	—
Iraq	2,100	—	1,955	—	685	—	4,740	—	4,740
Ireland	170	—	—	—	—	—	170	—	—
Italy	333	1,447	—	48	—	—	333	1,495	1,828
Ivory Coast	—	—	—	—	—	—	—	—	—
Japan	1,080	—	—	—	10	—	1,090	—	1,090
Kenya	—	—	—	—	260	—	—	260	260

(Continued)

Through the bog in old Kauri forest in New Zealand, the products and gas lines were covered with slats to protect against buried logs and roots.

across the Red Sea to Port Sudan, then by pipeline across Sudan, the Central African Republic, and Cameroon, to a port at Douala. Cost is estimated at \$10 billion.

Work on Nigeria's Escravos-Lagos pipeline project is expected to get underway in early 1985. Snamprogetti is doing survey and design work on the 216-mile, 36-in. gas line. Sister company Saipem has contract for construction.

Australia. Natural gas may come to Darwin on the north coast as result of ambitious plans to transport the fuel from the Amadeus Basin in Palm Valley. The 800-mile line would cost \$250 million.

Middle East. Iraq is feverishly working on two plans to move its crude oil produc-



tion to new ports to avoid the strife in the Arabian Gulf. Priority plan is for a 500-mile-plus line from Haditha, Iraq, to Aqaba, Jordan, that would initially handle 500,000 b/d. Cost would be \$1 billion. Bechtel reportedly is designing and will supervise this line's construction.

A second proposed line would originate at Rumaila, Iraq, and run south to the Petromin Yanbu oil line. Eventually, from that junction point, Iraq would finance and build a parallel line to Yanbu. Cost would be \$3 billion.

South America. In Colombia, contract has been let to Mannesman Anlagenbau AG and IMEG to build the \$170-million, 184-mile crude oil line from Canon Lina field in northeastern Colombia across the Andes to Rio Zulia.

Brazil is completing its 254-mile Nordeste gas pipeline system in northeastern Brazil that will aid industrial development.

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WORLD PIPELINES - PLANNED AND UNDER CONSTRUCTION - BY COUNTRY

(As of October 1, 1984)

	Gas Pipelines		Crude Pipelines		Products Pipelines		Country Totals		Total
	Planned	U/C	Planned	U/C	Planned	U/C	Planned	U/C	
Korea	—	—	454	—	440	—	894	—	894
Kuwait	273	—	74	—	—	—	347	—	347
Libya	—	354	—	—	—	—	—	354	354
Malaysia	609	200	100	—	50	—	759	200	959
Mexico	624	392	334	—	703	175	1,661	567	2,228
Netherlands	404	27	247	—	15	—	666	27	693
New Zealand	181	128	32	—	—	—	213	128	341
Nigeria	2,786	—	—	—	—	—	2,786	—	2,786
Norway	128	—	—	—	—	—	128	—	128
North Yemen	—	—	—	—	236	—	236	—	236
Oman	399	—	968	130	—	—	1,367	130	1,497
Pakistan	985	—	540	—	—	—	1,525	—	1,525
Panama	—	—	—	—	81	—	81	—	81
Peru	—	—	373	—	—	—	373	—	373
Portugal	—	—	—	—	69	—	69	—	69
Qatar	—	—	—	—	41	—	41	—	41
Saudi Arabia	650	189	879	—	810	—	2,339	189	2,528
South Africa	—	—	—	—	93	—	93	—	93
Spain	1,770	—	—	—	—	89	1,770	89	1,859
Sri Lanka	—	—	10	—	20	—	30	—	30
Sudan	—	—	—	935	—	935	—	1,870	1,870
South Yemen	—	—	—	—	177	—	177	—	177
Sweden	1,286	65	—	—	—	—	1,286	65	1,351
Taiwan	160	—	—	—	—	—	160	—	160
Tanzania	—	—	—	—	678	—	678	—	678
Thailand	322	27	316	—	361	—	999	27	1,026
Tunisia	472	—	—	—	370	—	842	—	842
Turkey	1,090	—	—	280	125	—	1,215	280	1,495
U.K.	690	184	—	—	—	—	690	184	874
U.A.E.	124	—	—	—	164	—	288	—	288
U.S.S.R.	3,808	2,416	640	240	—	—	4,448	2,656	7,104
Uruguay	189	—	—	—	—	—	189	—	189
Venezuela	497	—	154	—	—	—	651	—	651
Vietnam	—	—	235	—	—	—	235	—	235
West Germany	584	111	—	—	—	—	584	111	695
Yugoslavia	—	—	—	—	—	—	—	—	—
Zaire	—	—	—	—	205	—	205	—	205
Zambia	—	—	—	—	—	—	—	—	—
Zimbabwe	—	—	—	180	—	—	—	180	180
TOTALS	62,699	8,162	15,959	2,304	8,279	1,614	86,927	12,080	99,007